Wandel U. Goltermann

Voltage and Level Meter TFPM-76

Description and Operating Manual

BN 176 UV

MP MASTER

MA29291

BAYTRON SYSTEMS CORP.
1720 Newport Circle
Santa Ana, Calif. 92705

VOLTAGE AND LEVEL METER TFPM-76

for selective and wideband measurements in the frequency range 300 Hz to 1.35 MHz (1.4 MHz)

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1.9.62

0.2.4.70 1899 UN v. 1777

Printed in Western Germany

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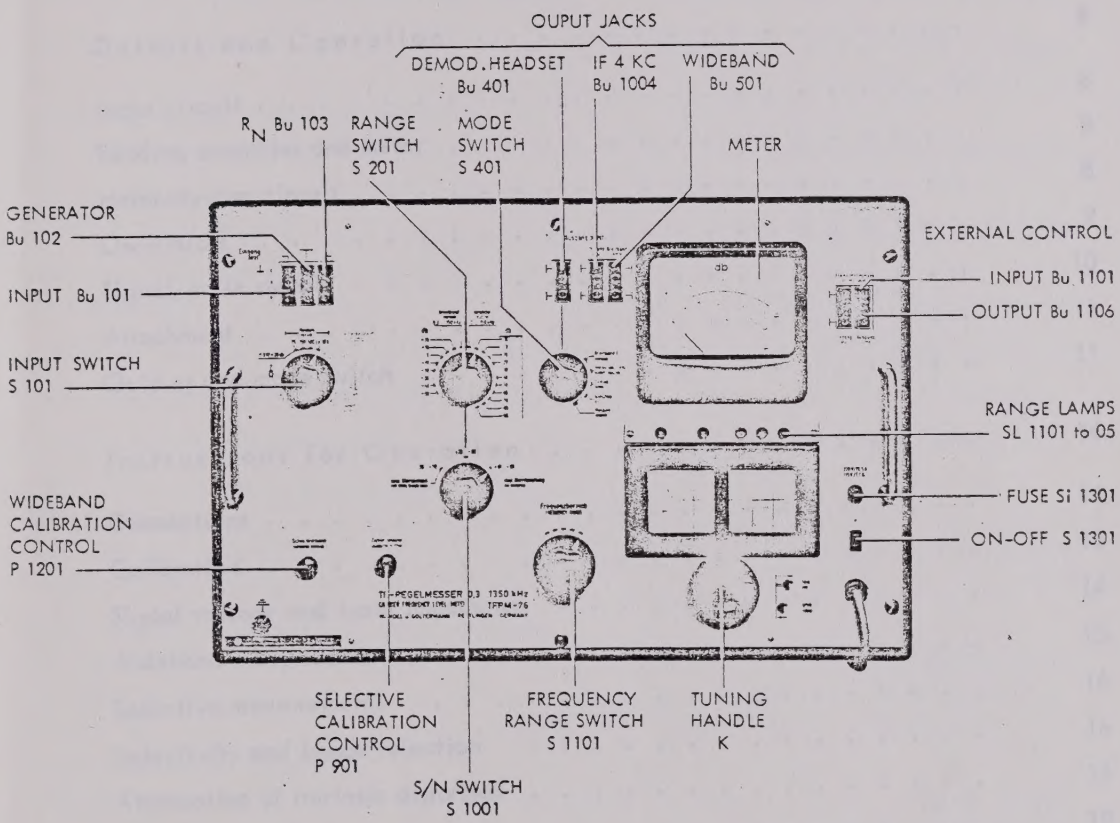
OUPUT JACKS
DEMOD. HEADSET Bu 401
IF 4 KC Bu 1004
WIDEBAND Bu 501
R N Bu 103
RANGE SWITCH S 201
MODE SWITCH S 401
METER
GENERATOR Bu 102
INPUT Bu 101
INPUT SWITCH S 101
WIDEBAND CALIBRATION CONTROL P 1201
EXTERNAL CONTROL
INPUT Bu 1101
OUTPUT Bu 1106
RANGE LAMPS SL 1101 to 05
FUSE Si 1301
ON-OFF S 1301
SELECTIVE CALIBRATION CONTROL P 901
S/N SWITCH S 1001
FREQUENCY RANGE SWITCH S 1101
TUNING HANDLE K

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RATINGS

Values in brackets refer to Neper version.
dB/V - version : BN 176/0; Np - version : BN 176/1

WIDEBAND MEASUREMENTS

Frequency range	300 Hz to 1.35 MHz
Measuring range for 0 dB (0 Np) meter reading	-50 dB to +20 dB (-6 Np to +2 Np)
Meter scale range	-30 dB to +1 dB (-3 Np to +0.3 Np) 0 to 8 V, 0 to 2.5 V
Accuracy for zero range and deflection at 100 kHz after calibration [2]	0.1 dB (0.01 Np) and better
Range switch accuracy at 100 kHz, ref. to zero dB or Np range [2]	0.1 dB (0.01 Np) and better
Accuracy of switch S 1001, ref. to centre position	0.1 dB (0.01 Np) and better
Frequency response ref. to 100 kHz flat to max.	0.2 dB (0.02 Np)
Scale accuracy, ref. to full-scale value	1.5 % and better
Input impedance, switchable [1]	10 kΩ, 600 Ω, 150 Ω, 75 Ω
Min. input impedance in switch pos. 10 kΩ	
at 5 to 600 kHz	10 kΩ
at 2 kHz and 1.35 MHz	4.5 Ω
at 300 Hz (inductive)	1 kΩ
Input impedance accuracy in other positions	
at 2 to 600 kHz	600 Ω ± 3 %
at 2 kHz to 1.35 MHz	150 Ω ± 1 % or 75 Ω ± 1 %
at 300 Hz	600 Ω ± 10 % or 150 Ω - 3 % or 75 Ω - 2 %
Min. unbalance attenuation	
300 Hz to 600 kHz	52 dB (6 Np)
at 1.35 MHz	43 dB (5 Np)
Effect of supply voltage fluctuations upon	
reading, without calibration, max.	0.2 dB (0.02 Np)
change of calibration level, max.	0.03 dB (0.003 Np)
Temperature coefficient between 0 and +40° C, effect upon	
reading, without recalibration, max.	0.02 dB/ °C (0.002 Np/ °C)
change of calibration level, max.	0.01 dB/ °C (0.001 Np/ °C)

1) The input impedances 75, 150, 600 Ω are to be used only with signal levels not exceeding +20 dB (+2 Np).

2) S/N switch S 1001 in centre position.

SELECTIVE MEASUREMENTS

Frequency range	2 kHz to 1350 kHz in single range
4 subranges	2 to 300 to 600 to 900 to 1350 kHz
Frequency accuracy in subrange after 2 hours of operation	± 0.2 % ± 1 kHz and better
Frequency drift in subranges after 2 hours of operation	1×10^{-4} ± 100 Hz/hour
Measuring range for 0 dB (0 Np) meter reading	-90 to +30 dB (-11 to +3 Np)
Meter reading range	-30 dB to +1 dB (-3 Np to +0.3Np) 0 to 8 V, 0 to 2.5 V
Accuracy for zero range and deflection at 100 kHz after calibration	± 0.1 dB (± 0.01 Np) and better
Range switch accuracy at 100 kHz ref. to 0 dB or 0 Np	± 0.2 dB (± 0.02 Np) and better
S/N switch accuracy ref. to range +20 to -80 dB (+2 to -10 Np)	± 0.1 dB (± 0.01 Np) and better
Frequency response ref. to 100 kHz flat to max.	± 0.2 dB (± 0.02 Np)
Scale accuracy, ref. to full-scale value	1.5 % and better
Input impedance	as for WIDEBAND MEASUREMENTS
Selectivity in passband range Attenuation $\Delta f \leqq \pm 100$ Hz, max.	1 dB (0.1 Np)
Selectivity in stopband range Attenuation $\Delta f \geqq \pm 500$ Hz, min.	60 dB (7 Np)
IF and image rejection, min.	60 dB (7 Np)
Attenuation of intrinsic distortion when sensitivity is increased by 60 dB (7 Np) over input sum level, min.	80 dB (9.5 Np)
Interference reading with open-circuit input and max. sensitivity, oscillator tuned to 2 kHz max.	-115 dB (-13.5 Np)
12 kHz or higher frequency, max.	-120 dB (-14 Np)
Effect of ± 10 % supply voltage fluctuation upon reading after retuning, max.	0.3 dB (0.03 Np)
receive frequency, max.	$\pm 1 \times 10^{-4}$ ± 10 Hz
Temperature coefficient between 0 and +40° C, effect upon reading max.	0.05 dB (0.005 Np/ °C)

2) This applies to fundamental waves up to the measuring range +10 dB (+1 Np)and to fundamental frequencies of at least 12.5 kHz. Only a sensitivity increase of 50 dB (6 Np) is permissible for the fundamental-wave measuring range +20 dB (+2 Np)

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IMPEDANCE MEASUREMENTS

Frequency range . . . . . 0.8 kHz to 1.35 MHz

Measurements of absolute impedance values

Measuring range, f.s.d . . . . . 10 Ω to 1 kΩ
Highest absolute value measurable . . . . . 5 kΩ

Instrument reading range . . . . . 50 to 10 Ω

Measuring error
30 Ω to 1 kΩ, $\varphi \leqq 30^{\circ}$ . . . . . $\leqq \pm 5\ \% \pm 1.5\ \%$ arc length
at 10 Ω and 3 kΩ, $\varphi \leqq 30^{\circ}$ . . . . . $\leqq \pm 10\ \% \pm 1.5\ \%$ arc length

Return loss measurements

Measuring range . . . . . 0 to 40 dB (0 to 4.6 Np)
Bridge unbalance attenuation, min. . . . . 60 dB (7 Np)

Impedance measurements with respect to absolute value and phase attachment standards, switch position BRIDGE
Measuring range . . . . . 10 Ω to 3 kΩ
Bridge unbalance attenuation, min. . . . . 60 dB (7 Np)

OUTPUT JACKS

Jack Bu 401, Switch S 401 in WIDEBAND position 1
Output level for full-scale reading (+1 dB or +0.3 Np)
at no-load condition, approx. . . . . +3 dB (+35 Np)
Output impedance . . . . . 600 Ω

Jack Bu 401, Switch S 401 in position HEADSET SELECTIVE
Output level for full-scale reading (+1 dB or +0.3 Np)
when load resistance = 15 Ω, approx. . . . . +5 dB (+0.58 Np)
Output impedance, approx. . . . . 15 Ω
Output voltage frequency . . . . . 1 kHz

Jack Bu 401, Switch 401 in pos. DEMODULATOR
Output DC voltage for full-scale reading (+1 dB or +0.3 Np) [3]
at no-load condition, approx. . . . . 16 mV
Output impedance [3] . . . . . 100 Ω shunted by 10 nF

[3] In Series H and J the equipment, the output DC voltage at no load is about 32 mV and the output impedance 200 Ω shunted by 10 nF.

Jack Bu 401, Switch S 401 in DC position
Output DC voltage for full-scale reading (+1 dB or +0.3 Np)
at no load condition, approx . . . . . 215 mV
Output impedance . . . . . 275 Ω shunted by 250µF
Permissible load resistance (Bu 401 is parallel to meter), min. . . . . 50 kΩ

Jack IF 4 kHz, Bu 1004
for connection of LGV-1 for selective operation
Max. output level (with LGV-1 attached) . . . . . +10 dB (+1 Np)
Input level for output +10 dB (+1 Np) in meas. range
-90 dB (-11 Np) when S/N Switch S 1001 adjusted
to +10 to -90 dB (+1 to -11 Np) respectively . . . . . -35 dB (-4 Np)

Jack WIDEBAND II, Bu 501
Output level for full-scale reading (+1 dB or +0.3 Np)
when load resistance = 75 Ω, approx. . . . . +3 dB (+0.35 Np)
Impedance, approx. . . . . 75 Ω

Valve complement . . . . . 13 x 18042, 1 x 85 A 2
Supply voltage required . . . . . 110, 115, 220, or 240 V, 45 to 60 Hz
Power consumption . . . . . 60 W

Weight . . . . . 24 kg

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GENERAL

The Carrier Frequency Level Meter TFPM-76 is a versatile measuring set for wideband and selective frequency response and impedance measurements. In wideband operation, levels can be measured in the frequency range 300 cps to 1.35 mc. Impedances between 10 ohms and 5 kilohms may be measured in the same frequency range.

For selective measurements, this overall frequency range is available in addition to its four subranges. This arrangement helps to quickly locate an unknown frequency on the scale of the full range or to obtain an idea on the whole spectrum of mixed frequencies. The subranges then permit to fully exploit the high accuracy of the Level Meter. Each range has its own signal lamp indicating what range is in operation.

An advantage associated with the Level Meter is that external control can be applied to the tuning operation. When thus a measurand (fourpole, transmission line, loop) is connected between the Level Meter and a carrier-frequency signal generator, the frequency need be adjusted on either the generator or the level meter, not on both. For this operation, an extra channel between generator and Level Meter is required; otherwise this operation is ensured by design details : The Carrier Signal Generator TFPS-75 is a beat-frequency generator and the Level Meter TFPM-76 is a double superhet receiver, the first IF of both being the same. This feature enhances the convenience of operation.

The Generator TFPS-75 and the Level Meter TFPM-76 can be combined into a setup permitting measurements to be obtained in the range 2 kc to 1.35 mc from measurands introducing a maximum attenuation of 120 db or 14 nepers (N).

The Level Meter TFPM-76 is, moreover, equipped for use in sweep-frequency measuring setups (for instance, in the setups WM-2 and WM-4). For this operation, it contains a wideband output for the control of the discriminator in the display unit of the sweep-frequency setup and a signal-to-noise ratio switch (S/N SWITCH) permitting to adjust for the best ratio and maximum attenuation of distortion, depending on the measuring problem in hand. Example : When the Log Amplifier LGV-1 is employed, it is possible to present, on the screen of the Display Unit SG-1, frequency-response characteristics having attenuation excursions as wide as 90 db or 10 N.

DETAILS AND OPERATION

The Carrier Level Meter TFPM-76 comprises a wideband level meter and a superhet section for selective measurements of levels. A built-in attachment for impedance measurements may be switched into the input of either. A calibration oscillator permits absolute calibration. A block diagram of the set is shown in the appendix.

Input Circuit

An attachment for impedance measurements may be switched into the input circuit by switch S 101. In the case of level measurements, the input voltage is directly applied to a balanced high-impedance input transformer. The primary of this transformer can be loaded with the most commonly used termination resistances by switch S 101. The input voltage is then applied, via voltage divider S 201, to the preamplifier having a high negative feedback and operating extremely linearly. Moreover, switch S 201 can be positioned so that the internal calibration voltage is applied to the preamplifier input. Finally, S 201 serves to change-over from wideband to selective measurements via a relay.

Reading Amplifier with Meter

In wideband operation, the preamplified voltage is passed through a 300-cps highpass filter network to the reading amplifier, a mean-value rectifier, and the meter. This final amplifier is stabilized by substantial negative feedback just as the preamplifier.

In selective operation, the final amplifier is driven by the signal voltage converted to a frequency of 4 kc. This intermediate frequency (IF) of 4 kc is applied via a rectifier to the meter and to the output jack Bu 1004. The amplified signal voltage can be converted, in a self-oscillating mixer, to the frequency of 1 kc which is filtered and is then available across the output jack Bu 401. In this way, even very weak input signals can be made audible in a headset.

Heterodyning Circuit

In selective measurements, the preamplified input voltage is applied via a low-pass

filter network to Modulator I. This modulator is controlled by a tunable oscillator I with a frequency between 2.002 and 3.35 mc so that any signal frequency between 2 kc and 1.35 mc is converted to the IF of 2 mc. The image frequencies in the band 4.002 to 5.35 mc are suppressed in a lowpass filter network so that the image frequencies are almost completely rejected. The signal frequency converted to 2 mc is passed through a crystal filter and then amplified. Another frequency conversion to the 2nd IF of 4 kc takes place in Modulator II. The crystal oscillator supplies the control frequency of 1.996 mc. The crystal filter 2 mc has a particularly high attenuation at 1.992 mc so that this second frequency conversion is again essentially protected against image frequencies. The 4-kc voltage is amplified and passed through a bandpass filter to the final amplifier and the meter. The multi-circuit 4-kc bandpass filter is important for the selectivity of the set.

The selective part operates still with extreme linearity even when overloaded by 60 db or 7 N. Hence, when the measuring range -60 db | -7 N is used, even very low partial voltages can be filtered out and measured from a rms voltage of, say, 0 db or 0 neper.

The selective part is tuned exclusively by changing the modulator I control frequency. Normally this is supplied by Oscillator I; however, an external control frequency is just as effective. Thus the selective part can be tuned by external means. This feature was provided because the Signal Generator TFPS-75 provides the necessary control voltage, the frequency of which changes with the generator frequency so that the receive frequency in the Level Meter is adjusted in synchronous operation. In this way, the Level Meter can be tuned from the Signal Generator; conversely, the generator may be tuned by operating the controls of the Level Meter.

Oscillators

The tunable LC oscillator I can be tuned arbitrarily through the overall frequency range or, if so desired, through the four subranges between 2 and 3.35 mc. Its resonant circuit comprises an air coil, ceramic capacitors, and a variable capacitor. The temperature dependence of these components is very low and to a great extent compensated.

The Oscillator II frequency is stabilized by a crystal. Hence, optimum values are achieved in respect of the receive frequency accuracy and excursion in time as this frequency

essentially on the accuracies of the two oscillator frequencies.

Owing to circuit dimensioning, the calibration oscillator amplitude is determined solely by the properties of a thermistor bridge. The thermistor is aged, and the bridge is temperature-compensated so that the calibration level remains constant for a long time. The accuracy of the calibration level controls the absolute measuring accuracy of both the selective and the wideband parts of the Level Meter.

Signal/Noise Switch

The higher the gain of a Level Meter, the smaller the input voltages that are still measurable. If the sensitivity is adjusted only by the input divider leaving the gain unchanged, the following limitations will be controlling: Very small input levels are of the order of noise voltages and cannot be measured. Very high input levels introduce distortion in the amplifier. On the other hand, sweep-frequency measuring calls for presentation of characteristics having excursions of up to 90 db or 10 N; this has to be accomplished in one sensitivity range only, and yet the lowest levels should not be drowned in noise. On the other hand, this range of levels should be utilized at different input sensitivities. For these reasons, a S/N switch S 1001 is provided on the front panel of the Level Meter TFPM-76 BN-176. This switch operates an attenuator before the reading amplifier. In position MAX. S/N RATIO of this switch, the attenuation of the reading-amplifier input amounts to 20 db or 2 N; in the central position, this attenuation will be 1 N or 10 db, and in the position MIN. DISTORTION the full gain becomes effective. A simplified diagram Fig. 2 illustrates these functions.

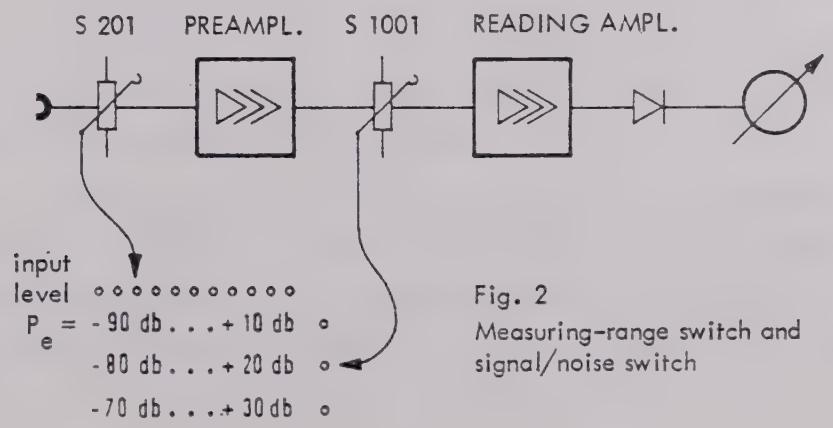


Fig. 2
Measuring-range switch and signal/noise switch

Attachment for Impedance Measurements

This attachment permits measuring of the modulus of impedance and of the unbalance of passive circuits within the frequency range 0.8 kc to 1.35 mc.

For impedance measurements, the measurand in series with the Level Meter is connected to a generator. The measurand and the Level Meter input resistance form a voltage divider. When the signal-generator level is defined, the partial voltage appearing across the Level Meter input is directly proportional to the absolute impedance introduced by the measurand. In bridge connection, connection of resistance standards provides the means of measuring impedance by magnitude and phase or mismatch attenuation.

Outputs and Mode Switch

MEASURE

When the mode switch S 401 is in its 5 th position MEASURE, the level meter may be used in its original function to measure levels with direct readings or to measure impedances or to obtain bridge measurements. The measurement can be directly taken from the meter, paying due attention to the range adjusted.

DC

When the mode switch is in position DC, the rectified signal voltage will be available across jack Bu 401 DEMOD.HEADSET which is parallel-connected to the meter. The reading is not affected by a load resistance of 50 kΩ or greater. In this mode of operation, the direct voltage across jack Bu 401 is about 240 millivolts at no-load condition when the meter needle is fully deflected (+1 db or +0.3 N).

In this mode, a measuring instrument with larger scale expansion or a recorder having a highly resistive input circuit can be connected to the Level Meter. On the other hand, a large smoothing capacitor can be parallel-connected to the built-in meter via jack Bu 401 when, for instance, the reading has to be smoothed in white-noise measurements.

DEMOD

In the central position DEMOD of the mode switch, the meter is disconnected. The demodulated output voltage of the reading amplifier appears across jack Bu 401; its frequency corresponds to the input frequency in wideband measurements and is 4 kc in selective measurements. This switch position is provided to present the demodulated signal, especially for application in the sweep-frequency measuring setup WM-4. In position DEMOD the sensitivity of the Level Meter, that is, the gain of the reading amplifier, is reduced by the factor 5, that is, by 14 db or 1.6 N. When the mode switch is first positioned to MEASURE and the input level is adjusted to full-scale reading (+1 db or +0.3 N) and then switched back to DEMOD, the output voltage across jack Bu 401 will be 16 millivolts with an internal resistance Ri = 100 Ω. (In Series H and J of the Level Meters, the corresponding figures are 32 mv and Ri = 200 Ω). Now the input level may be increased by the factor 5, and the output voltage will be max. 80 mv (or 160 mv in Series H and J). Owing to the decreased gain and disconnection of the meter, the control range is expanded five times. In sweep measurements, far greater level differences can thus be displayed on the screen of SG-1 than would be possible with the inertial meter needle.

HEADSET SEL. 1 KC

In position HEADSET SEL. 1 KC of the mode switch, the last stage of the reading amplifier is changed into a self-oscillating mixer stage at 5 kc. The use of the IF = 4 kc thus gives a frequency of 1 kc that is passed through a lowpass filter attenuating the mixer product of 6 kc and applied to jack Bu 401 for headset operation. The meter is switched off. Utilizing the sensitivity of the ear, the null or minimum in bridge measurements can be determined with good resolution even when the input voltage is very low. Using the overall frequency range, a voltage of unknown frequency can be conveniently located in this operation while a meter would be useful only if the tuning means are operated exceedingly slowly. In this mode, the internal resistance of the output circuit is 15 kΩ approx. For a load resistance of 15 kΩ, the voltage is about 1 volt when the instrument gives a full-scale reading (+1 db or +0.3 N) after the mode switch has been positioned to MEASURE, all other conditions remaining unchanged.

WIDEBAND I

In this position of the mode switch S 401, the Level Meter operates as a measuring-signal amplifier. The output voltage of the reading amplifier is available from jack Bu 401, DEMOD HEADSET. In wideband operation, the output-voltage frequency corresponds to the input-signal frequency. In selective operation, the output-voltage frequency is 4 kc.

In mode WIDEBAND I, an AC recorder may be connected to the Level Meter. In operation with the sweep-frequency measuring setup WM-2, the preamplifier and demodulator VD-1 for vertical-sweep control of the Display Unit SG-1 is connected to jack Bu 401.

The no-load output level across jack Bu 401 is about +3 db or +0.35 N with Ri = 600 Ω in mode WIDEBAND I if full-scale reading is obtained (+1 db or +0.3 N) when the mode switch is changed to MEASURE.

Output Jack IF 4 KC (Bu 1004)

In selective operation, the IF (4 kc) voltage appears across jack Bu 1004. Here the logarithmic amplifier LGV-1 may be connected to present a range of input levels spanning 90 db or 10 N in one scale range. In the sweep-frequency measuring setup WM-4, the log amplifier LGV-1 thus permits to measure level differences up to 90 db or 10 N and to display these differences on the screen of the unit SG-1. The maximum IF level across jack Bu 1004 is +10 db or +1 N. For this output level, the input level across jack Bu 101 of the Level Meter should be about - 35 db or -4 N when the S/N switch S 1001 is positioned to MIN. DISTORTION and the subrange switch S 201 to -90 db or -11 N.

Output jack WIDEBAND II (Bu 501)

In wideband operation, the amplified reading voltage is applied to jack Bu 501. This jack can be connected to the discriminator input of the display-unit panel SGE-6 in the Display Unit SG-1 for wideband measurements in the sweep setup WM-4.

The output level across jack Bu 501 is about +3 db or +0.35 N when the meter needle is deflected full-scale (+1 db or +0.3 N) after the mode switch has been positioned to MEASURE. The internal resistance of the output jack Bu 501 is around 75 ohms, and the level indicated appears when the load resistance is 75 ohms.

INSTRUCTIONS FOR OPERATION

Connections

Connect the set to a power line 45 to 60 cps. It is adjusted to a supply voltage of 220 V AC when delivered; change the connections on the power transformer if your local voltage is 240, 110 or 115 volts. The fuse 0.5 amps is for voltages 220 and 240 volts; replace it by one rated 1 amp for 110 or 115 volts.

Calibration

Before switching the set on, check the meter for mechanical zero. Then switch the set on and allow for a warm-up period of 15 min. If measuring operation is to start immediately, check the calibration repeatedly during your work.

The wideband calibration control P 1201 affects the sensitivity of both the wideband and the selective circuits. The calibration control P 901 has an effect on the selective sensitivity only. Hence, first complete the wideband calibration with P 1201 and then the selective calibration with P 901.
For wideband calibration, position the sensitivity switch S 201 to WIDEBAND and operate the control P 1201 until the meter needle points to the red field.

For selective calibration, position switch S 201 to SELECTIVE and operate switch S 1101 and tuning handle K until the greatest needle deflection is obtained at 100 kc. (For frequency adjustments refer to Section Selective Measurements below). Operate control P 901 until the meter needle points to the red calibration mark.

Signal Voltage and Input Impedance

CAUTION : DO NOT FEED DIRECT CURRENT TO THE INPUT !

Feed the signal voltage to jack Bu 101 using a balanced shielded plugs. These cables have in most cases a characteristic impedance of 150 Ω. If you need an input impedance different from the cable characteristic impedance, use short cables only to prevent erroneous measuring. For high-resistance measurements, the cable capacitance will

reduce the input impedance; moreover, a long mismatched cable may transform the voltage. However, no noticeable errors are introduced by cables not longer than 1 m.

The signal voltage is balanced in most cases and is connected to terminals 'a' and 'b' of Bu 101 while terminal 'c' is grounded. In the case of an unbalanced signal voltage, connect terminal b to ground (terminal c).
Adjust the desired input resistance by S 101. When the input resistance is high, the impedance depends on the frequency as shown in Fig. 3.

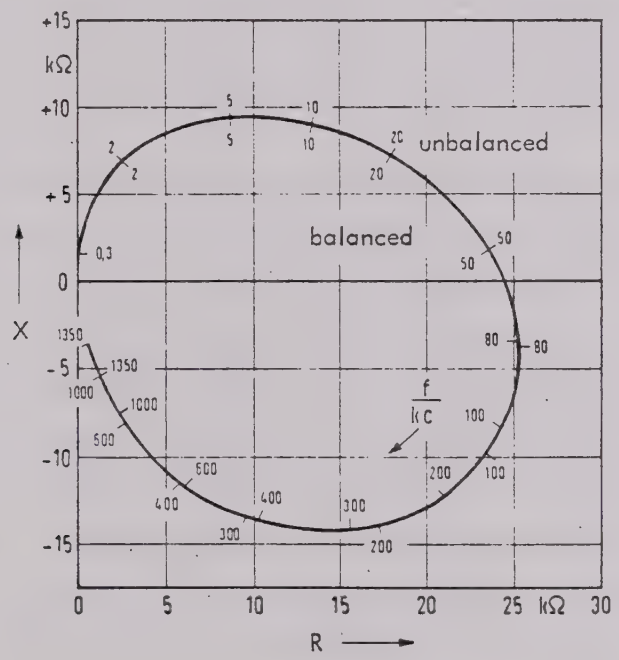


Fig.3 Circular diagram of the input impedance for wideband and selective measurements when input switch S 101 is positioned to 10 kΩ. The values designated unbalanced, are obtained when the input is made unbalanced, that is, terminals b, c of jack Bu 101 are interconnected.

Wideband Measurements

Operating switch S 201 in the WIDEBAND range, increase the sensitivity until good needle deflection is obtained. The signal level is then obtained from the sum of the values adjusted by S 201 and read from the meter.

Example : S 201 in pos. -20 db, meter reading -7 db : Signal level -27 db
S 201 in pos. -2 N, meter reading -0.6 N : Signal level -2.6 N

The meter is calibrated in rms voltage levels (0 neper = 0 db = 0.775 volt). It responds to the mean value of the voltage. If the signal voltage is nearly sinusoidal, the reading is identical with the rms value.

Selective Measurements

Use the selective mode of operation if the sensitivity of the wideband measuring procedure is insufficient; when interfering voltages are superimposed on the signal voltage; or when the signal voltage is composed of partial voltages at different frequencies. Thus the spectrum of distorted voltages containing harmonics or of modulated voltages can be measured.

Adjust to the desired receive frequency, operating the frequency-range switch S 1101 and the tuning handle K, observing the scale in question. The scale in operation is indicated by a signal lamp. To find an unknown frequency, use the overall range. The subranges permit convenient tuning to the known frequency, and at greater accuracy.

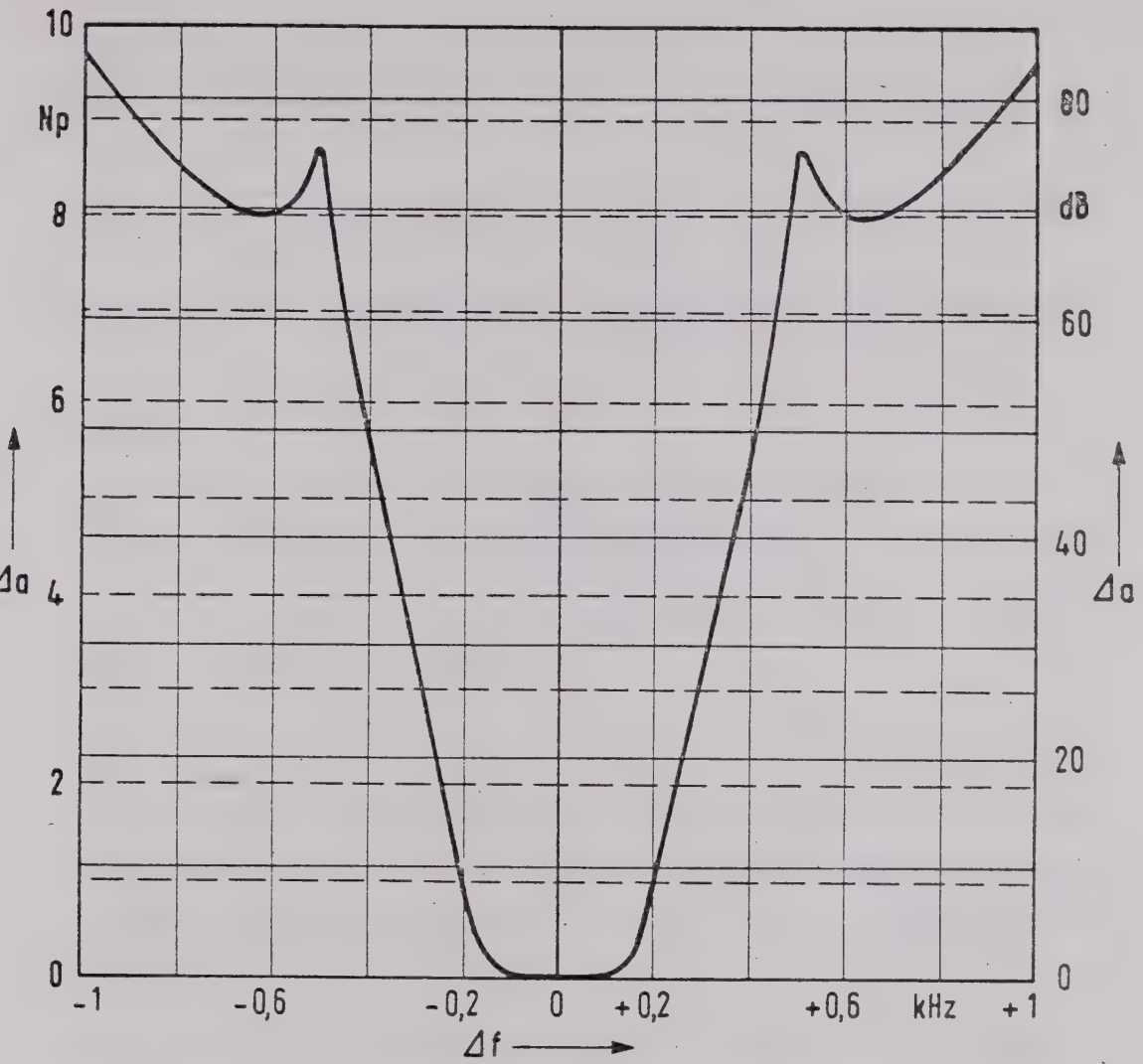
Adjust the sensitivity switch S 201 to a sensitivity corresponding to the level expected. Find the signal frequency by operation of handle K, adjust to greatest needle deflection. Take the reading exactly as in the case of Wideband Measurements.

The sensitivity ranges adjusted by switch S 201 may be shifted by max. 20 db or 2 N with the S/N switch S 1001. You may this choose between the highest signal/noise ratio and highest sensitivity with highest attenuation of distortion.

Selectivity and Image Rejection

Fig. 4 shows the selectivity characteristic of the Level Meter. When you detune against midband, the attenuation is steadily increased (at ± 100 cps it is less than 1 db or 0.1 N). When you have detuned by ± 500 cps or more, the attenuation will be 70 db or 8 N. The bandwidth important for whitenoise voltages is about ± 170 cps.

Image frequencies are received when the input voltage has a frequency 4 mc above or 8 kc below the input frequency adjusted. In this case, the attenuation of unwanted frequency is 70 db or 8 N. Regardless of the tuning, a signal voltage at 2 mc (first IF) can



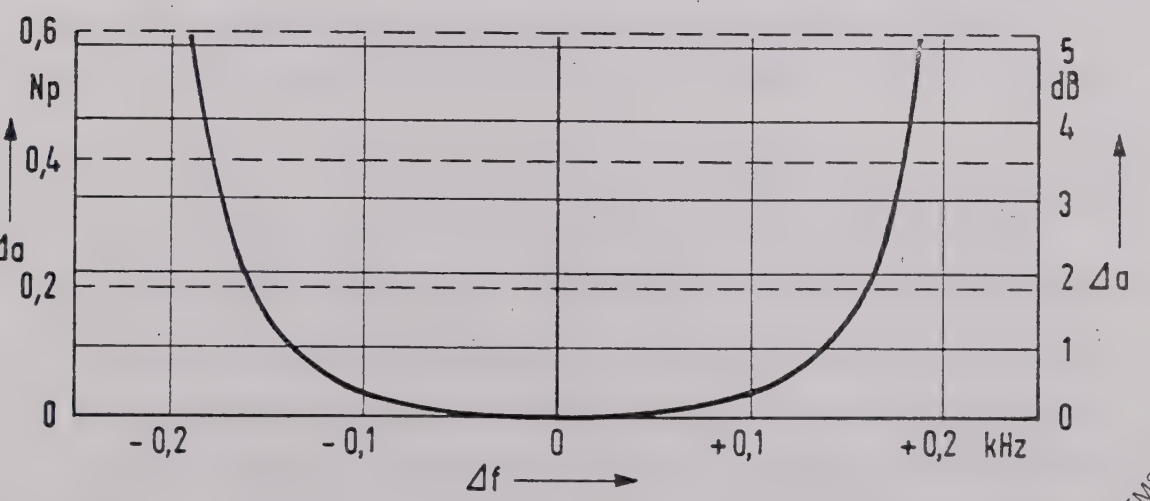


Bild 4 Selektionskurve des Pegelmessers TFPM-76
Fig. 4 Selectivity characteristic of the Level Meter TFPM-76

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result in reception; here the attenuation will be greater than 80 db or 9 N in most cases.

Attenuation of Intrinsic Distortion

Owing to distortion in the selective input circuit, harmonics of a signal voltage may be indicated by the measuring circuits even if it is free of harmonics. This action increases at higher sensitivity adjusted by switch S 201 compared with the fundamental-frequency level.

If a sensitivity is switched on that is by 70 db or 8 N higher than for the fundamental-wave level, for instance, if you measure in the range -90 db | -11 N while the fundamental level is -20 db | -2.3 N, then the attenuation of the intrinsic distortion remains greater than 80 db or 9.2 N. In the example given, the reading of the harmonics level would be less than -106 db or -12.2 N.

Due to this high linearity, the selective Level Meter can be used to measure very low partial voltages of a signal voltage having any spectrum. If you measure first the overall level in wideband mode and then adjust a sensitivity not greater than 60 db | 7 N for selective analysis, no new harmonics worth mentioning are generated and indicated. Increase this sensitivity (referred to the total level) only if you are sure that the partial-voltage level cannot be imitated by intrinsic distortion of the input circuits. As long as the reading of very low partial voltages is independent of the sensitivity adjusted by switch S 201, as long as a change of the sensitivity thus results in a change of needle deflection, you may be sure that the partial-voltage level indicated is actually present in the signal voltage and is not generated in the Level Meter.

External Control by Signal Generator TFPS-75

If the Level Meter is to be automatically tuned to the frequency of the Generator TFPS-75, connect the control output of the generator to the control-voltage input jack Bu 1101 of the Level Meter. Connect also the signal level output of the generator to the input jack Bu 101 of the Level Meter. Adjust the Level Meter sensitivity by switch S 201 to the generator level. Operating the fine-tuning control of the generator, adjust for maximum needle deflection on the Level Meter. Now connect the measurand between the two and measure it selectively so as you would do with a wideband level meter.

Do not operate the generator finetuning control during the measuring procedure.

The control input of the Level Meter is operated by a relay with a coil series-connected to the control output of the generator and the control input of the Level Meter. (The output of the generator is a low-resistance transformer through which the relay current may flow.) TUNE FINE TUNE TO LOCK

External Control by Generator TFPS-75 Series A, B, C

A Level Meter Series E and following, cannot be controlled directly by a generator of Series A, B, C having RC outputs for external control. However, a buffer transformer Bv 75-57 can be built-in where such connection is desirable. This transformer permits the use of an older generator with a later Level Meter.

At the same time, the buffer transformer prevents any ground connection between generator and Level Meter which can adversely affect the measurement in external-control operation.

Generator Tuning from Level Meter

It is also possible to control the Generator TFPS-75 from the Level Meter. When the setup is properly arranged, this may greatly facilitate the measuring procedure.

For this mode, the Level Meter has an output jack Bu 1106. Connect a cable between this jack and the control input jack Bu 9 of the Generator TFPS-75. Now the generator will be controlled by the 1st oscillator of the Level Meter. Connect also the signal output jack Bu 14 of the generator with the input jack Bu 101 of the Level Meter. Adjust by switch S 201 an input sensitivity corresponding to the generator level. Operate the fine-tuning control of the generator for greatest needle deflection of the Level Meter. Now connect the measurand between Generator and Level Meter. Do not alter the fine-tuning control position on the generator during the measuring procedure.

Operation in a Sweep Frequency Measuring Setup

For operation in the setup WM-2, connect the output jack Bu 401 DEMOD. HEADSET to the Preamplifier/Demodulator VD-1. Adjust the mode switch S 401 to the WIDEBAND I

position. When the setup WM-4 is used, connect the jack Bu 401 of the Level Meter to the Y input of the Display Unit Panel SGE-6. Adjust the switch S 401 to position DEMOD. For further details, refer to the descriptions of WM-2 or WM-4.

IMPEDANCE AND BRIDGE TYPE MEASUREMENTS

In all such measurements, feed the jack GENERATOR Bu 102 with a level of about +10 db or +1.15 N. (The Generator TFPS-75 is particularly suited to this mode). Connect the measurand to the input jack R_x (Bu 101). Connect the standard resistor required for bridge measurements to jack R_N (Bu 103). Remember that jack Bu 102 GENERATOR is grounded.

The Level Meter may in all cases be operated in the wideband or the selective mode. If the measurand could introduce interfering voltages, the selective mode is preferable. External control can be used in this mode.

Impedance Measurements

Connect a generator to jack GENERATOR Bu 102 (see Fig. 5). Connect the measurand to jack R_X (Bu 101). Adjust the switch S 101 to the position IMPEDANCE CALIBRATION. Adjust the range switch S 201 to the blue field -30 db or -4 N (lefthand for wideband, right-hand for selective mode). Adjust the S/N switch S 1001 to MIN. DISTORTION. Now turn to the generator and adjust its output level so that the Level Meter needle points to the calibration mark (10 in the ohms scale).

Adjust the Input Switch S 101 to one of the 5 impedance ranges where the needle deflection is maximum. The absolute impedance modulus can now be obtained in direct reading from the meter; observe the multiplication factor on switch S 101.

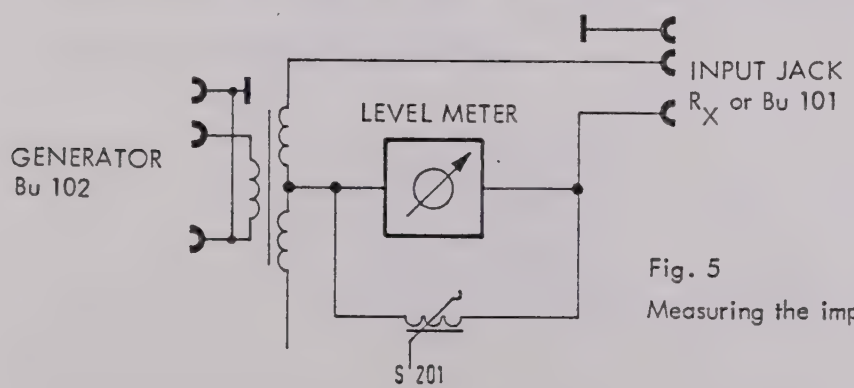


Fig. 5
Measuring the impedance modulus

Bridge Operation

A bridge circuit shown in Fig. 6 may be provided by operation of switch S 101. It comprises a differentiating transformer and the two outer-leg resistances R_X (unknown) and R_N (standard). The meter will then indicate the bridge output voltage.

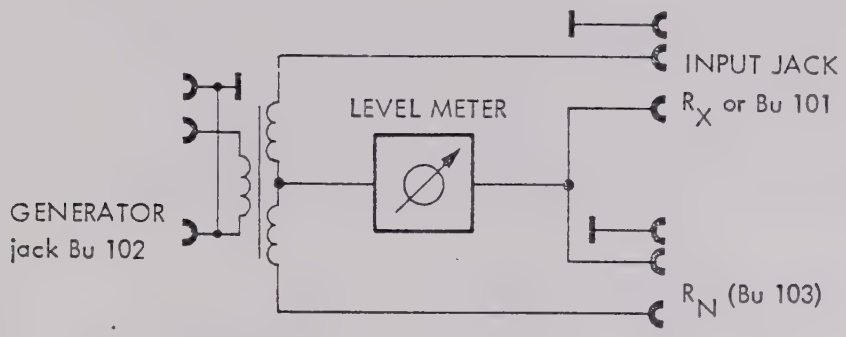


Fig. 6 Bridge Operation

For complex resistance measurements, simulate the unknown R_X by known, adjustable networks until the bridge output disappears, that is, no needle deflection is noticeable. Usually an adjustable standard resistor R_N and an adjustable standard capacitor C_N are employed. Both may be parallel or series connected. If R_X has an inductive component, connect C_N in series or parallel to R_X.

To measure mismatch attenuation, connect the reference standard resistance to the jack R_N. Now the bridge will not be exactly balanced in most cases. The negative voltage level across the bridge output, indicated by the Level Meter, corresponds to the mismatch attenuation. After a detuning (say $R_X = \infty$), a mismatch attenuation 0 db or zero N should be indicated. Adjust the feeding level of the generator accordingly.

The mismatch attenuation 'a_f' amounts to :

$$a_f = 20 \lg \left| \frac{R_x + R_N}{R_x - R_N} \right| \text{ db} \qquad \text{or}$$

$$a_f = \ln \left| \frac{R_x + R_N}{R_x - R_N} \right| \cdot N$$

Balance Attenuation Measurements

This measurement corresponds to the mismatch attenuation measurements of both impedances existing between the balanced terminal. If both impedances have the same magnitude and phase, any unbalance may be said to be infinitely attenuated. On the other hand, if complete unbalance prevails, for instance, when one leg is short-circuited, the attenuation of this unbalance is indicated as a reading 0 db or 0 N.

In position BALANCED of switch S 101, the bridge is connected to the jack R_X so that the mismatch attenuation of the resistors connected between terminals a and c is and between b and c is indicated by the meter. The circuit used is shown in Fig. 7 .

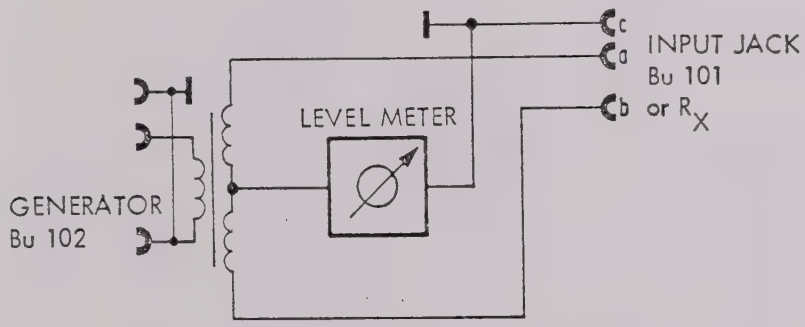


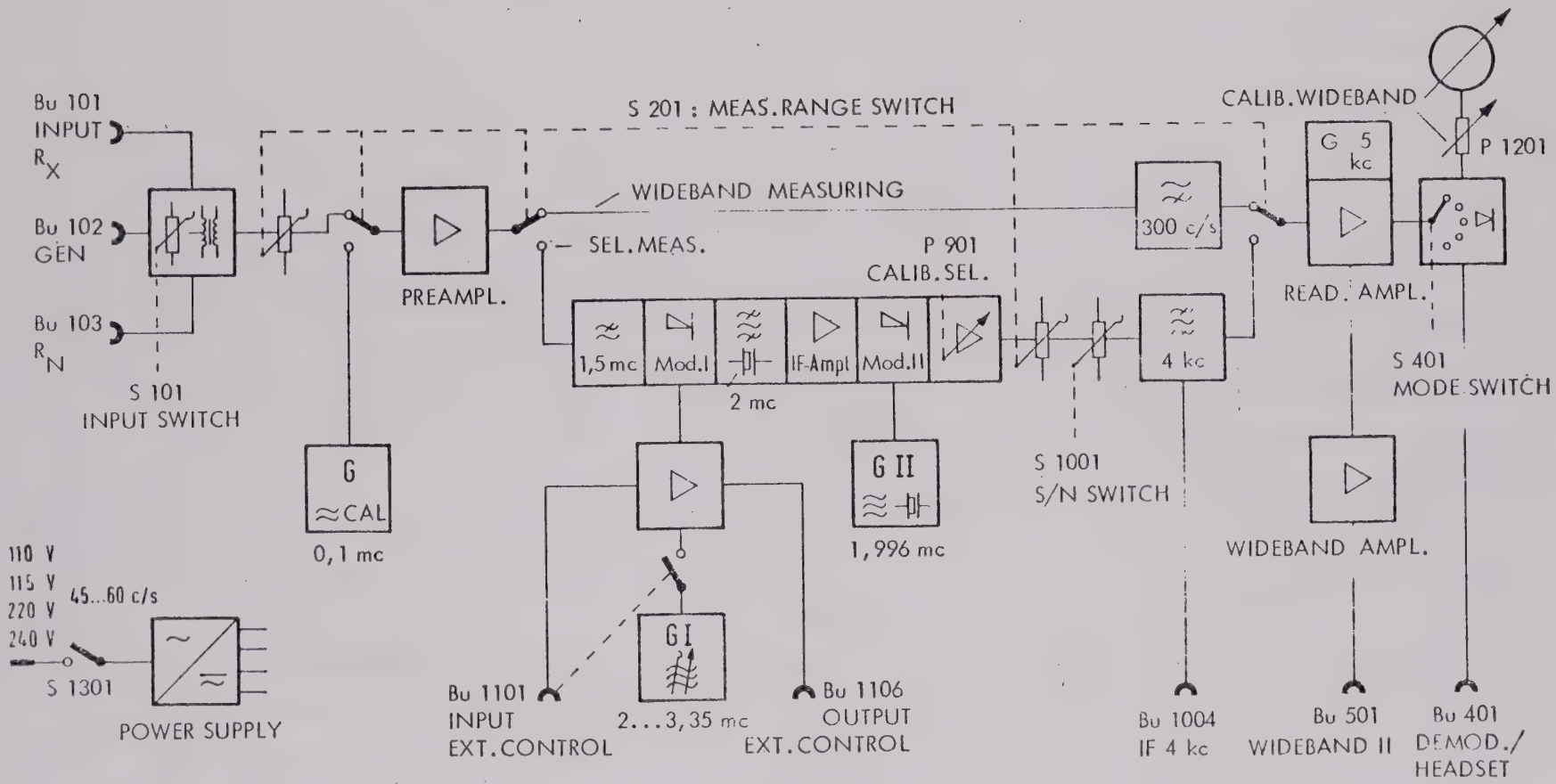
Fig. 7 Balance attenuation measurements

Do not connect anything to jack R_N if this jack is idle.

ATTENTION - Replacement of Tube Ro 1 Type 18042

Due to the production spread and microphonic sensitivity of these tubes, make sure you obtain an insensitive specimen for replacement.

Tubes with bad distortion properties may produce a permanent or temporary faulty reading in wideband measurements, e.g. by vibration. You may observe this in the selective mode, too, when using single discrete frequencies in the vicinity of 2 kc.

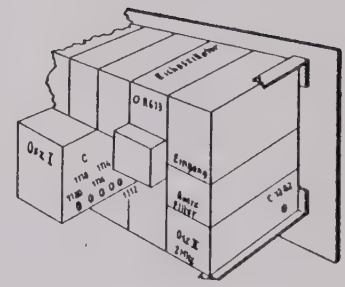


BLOCK DIAGRAM TFPM-76

No.	Testing of	x feed to o measure at	Rated voltage x open • parallel	frequency	Internal res. of signal voltage or input res. of Level Meter	Positions of switches and controls							Remarks Procedure
						S 101	S 1101	S 201	S 401	S 1001	P 901	P 1201	
1	Wideband part I	x St 401	x -3,45 N(-30db)	4 kc	0 Ω	-	-	-	Measure	-	-	turned on	Needle should be deflected full-scale
		• Bu 401	• +0,2 N(+1,7db)	4 kc	≅ 10 kΩ	-	-	-	Output wideband	-	-	-	
		• Bu 401	• +0,52 N (+4,5db)	1 kc	15 kΩ	-	-	-	Headset selec.	-	-	-	
		• Bu 401	• 14 mV	DC volt.	100 kΩ/V	-	-	-	Demod. output	-	-	-	
		• Bu 401	• 190 mV	DC volt.	100 kΩ/V	-	-	-	DC volt.	-	-	.	Control range of P 1201 is 0.18 N (1.6db)
2	Wideband part II	x St 501	x -1,35 N(-11,8db)	4 kc	330 Ω	-	-	-	-	-	-	-	Frequency response of amplifier ref. to 100 kc ≅ 5 % in range 300 cps
		• Bu 501	• + 0,1 N (+ 1 db)	4 kc	75 Ω	-	-	-	-	-	-	-	to 1.35 mc
3	Highpass Rel 301	x St 301	x -3,45 N (-30db)	4 kc	0 Ω	-	-	-5 N/WIDE (-40db/WIDE)	Measure	-	-	turned on	Needle should be deflected full-scale
		x St 302	x -3,45 N(-30db)	4 kc	0 Ω	-	-	-11 N/SELEC (-90db/SELEC)	Measure	-	-	turned on	Needle should be deflected full-scale
4	Input divider and preamplifier in WIDEBAND MEASURE	x St 201	x -7,53 N (-65 db)	4 kc	0 Ω	-	-	-6 N/WIDE (-50db/WIDE)	Measure	-	.	turned on	Needle should be deflected full-scale (if necessary check divider S 201)
5	Attachment overall set WIDEBAND	x Bu 101	• -5,8 N (-50 db)	4 kc	0 Ω	Measure 10 kΩ	-	-6 N/WIDE (-50db/WIDE)	Measure	-	-	turned on	Needle should be deflected full-scale
6	4-kc bandpass with divider and output	x Bu 1001	x -3,35 N (-29 db)	4 kc	20 kΩ	-	-	-11 N/SELEC (-90db/SELEC)	Measure	+1 N..-11 N (+10db..-90db)	-	turned on	Needle should be deflected full-scale
		x Bu 1001	x -2,35 N (-19 db)	4 kc	20 kΩ	-	-	-5 N/SELEC (-40db/SELEC)	Measure	+1 N..-11 N (+10db..-90db)	-	turned on	Needle should be deflected full-scale
	Bu 1004	x Bu 1001	x +0,65 N (+1 db)	4 kc	20 kΩ	-	-	-1 N/SELEC (-10db/SELEC)	Measure	+1 N..-11 N (+10db..-90db)	-	turned on	Needle should be deflected full-scale

No.	Testing of	x feed to • measure at	Rated voltage x open • parallel	frequency	Internal res. of signal voltage or input res. of Level Meter	Positions of switches and controls							Remarks Procedure
						S 101	S 1101	S 201	S 401	S 1001	P 901	P 1201	
	4 kc bandpass	x Bu 1001	x -2,35 N (-39 db)	4 kc	20 kΩ	-	-	-10 N/SELEC (-80db/SELEC)	Measure	+2 N..-10 N (+20db..-80db)	-	turned on	Needle should be deflected full-scale
6	with divider	x Bu 1001	x -1,35 N (-29 db)	4 kc	20 kΩ	-	-	-9 N/SELEC (-70db/SELEC)	Measure	+3 N..-9 N (+30db..-70db)	-	turned on	Needle should be deflected full-scale
	and output Bu 1004	• Bu 1004	• -6,1 N (-53 db)	4 kc	≧ 500 kΩ	-	-	-9 N/SELEC (-70db/SELEC)	-	+3 N..-9 N (+30db..-70db)	-	-	-
7	Oscillator II	• St 1201	• +0,8 N(+7db)	1,966 mc	high R against 100 Ω	-	-	-	-	-	-	-	-
8	IF amplifier and modulator II	x St 901	x -10,8 N (-93 db)	2,00 mc	0 Ω	-	-	-11 N/SELEC (-90db/SELEC)	Measure	+1 N..-11 N (+10db..-90db)	turned on	turned on	Needle should be deflected full-scale Control range of P 901 is 0.5 N
9	2-mc bandpass	x Bu 801	x -11,9 N (-102,6 db)	2,00 mc	75 Ω	-	-	-11 N/SELEC (-90db/SELEC)	Measure	+1 N..-11 N (+10db..-90db)	turned on	turned on	Needle should be deflected full-scale
10	Oscillator I	• Bu 1104	• +0,6 N(+5,2db)	2..3,35 mc	high R against 30 Ω	-	3	-	-	-	-	-	When Bu 1101 shorted, signal across Bu 1104 should disappear. If 0 db at
	with buffer stage ext. control	• Bu 1106	• 0 N (0 db)	2..3,35 mc	75 Ω	-	3	-	-	-	-	-	2.5 mc fed to Bu 1101, signal across Bu 1104 should be +0.6 N
11	Lowpass Modulator I	x St 701	x -8,4 N (-72,2 db)	100 kc	0 Ω	-	2	-11 N/SELEC (-90db/SELEC)	Measure	+1 N..-11 N (+10db..-90db)	turned on	turned on	After tuning Osc. I, to 100 kc, full-scale deflection should occur
12	Input divider and preamplifier for SELECTIVE MEASURE	x St 201	x -12,86 N (-107,2 db)	100 kc	0 Ω	-	2	-11 N/SELEC (-90db/SELEC)	Measure	+1 N..-11 N (+10db..-90db)	turned on	turned on	After tuning Osc.I, to 100 kc, full-scale deflection should occur
13	Attachment MEASURE complete set SELECTIVE	x Bu 101	x -11,13 N (-92,2 db)	100 kc	0 Ω	Measure 10 kΩ	2	-11N/SELEC (-90db/SELEC)	Measure	+1 N..-11 N (+10db..-90db)	turned on	turned on	After tuning Osc.I, to 100 kc, full-scale deflection should occur
14	Calibration osc.	• Bu 601	x -3 N(-26,1db)	100 kc	high R against 50 Ω	-	-	-	-	-	-	-	-
15	Attachment IMPEDANCE	x Bu 102	• +1,15 N(+10db)	100 kc	0 Ω	Impedance CAL	-	-4 N/WIDE (-30db/WIDE)	Measure	-	-	cal.	Needle should point to 10 Ω

Problem	Component	Procedure	
Calibration oscillator amplitude	R 613	Allow for warm-up period of min. 60 min. Feed level 0 db + 0.05 db at 100 kc to Bu 101. Switch S 201 to pos. 0 db/WIDEBAND, S 401 to MEASURE, S 101 to MEASURE 10 kΩ. Adjust needle to red mark by P 1201, then switch S 201 to CAL/WIDEBAND and again adjust needle to red mark by R 613.	
Oscillator II frequency	C 1202	Warm-up 60 min. Connect frequency meter to Bu 401. Signal frequency 4 kc. Switch S 401 to WIDEBAND 0.3 to 1350 kc. Switch S 201 to -10 db. Feed level -6 N at 2 mc ± 1 x 10^{-5} to St 901. Align with C 1202 until exactly 4 kc across Bu 401.	
Oscillator I frequency Range I	C 1112	S 1101 range 2-1350 kc, C 1109 to scale mark 0, align to exactly 4 kc output by C 1112	Allow for warm-up of min. 60 min. First align Oscillator II frequency.
Oscillator I frequency Range II	C 1114	S 1101 range 2-300 kc, C 1109 to scale mark 0, align to exaxtly 4 kc output by C 1114	Connect frequency meter to Bu 401
Oscillator I frequency Range III	C 1116	S 1101 range 300-600 kc, C 1109 to scale mark 300 kc; feed level 0 db at 300 kc to Bu 101, align to exactly 4 kc output by C 1116	Position switch S 401 to WIDEBAND and switch S 201 to 0 db or N.
Oscillator I frequency Range IV	C 1118	S 1101 range 600-900 kc, C 1109 to scale mark 600 kc; feed level 0 db at 600 kc to Bu 101, align to exactly 4 kc output by C 1118	
Oscillator I frequency Range V	C 1120	S 1101 range 900-1350 kc, C 1109 to scale mark 900 kc; feed level 0 db at 900 kc to Bu 101 mark align to exactly 4 kc output by C 1120	

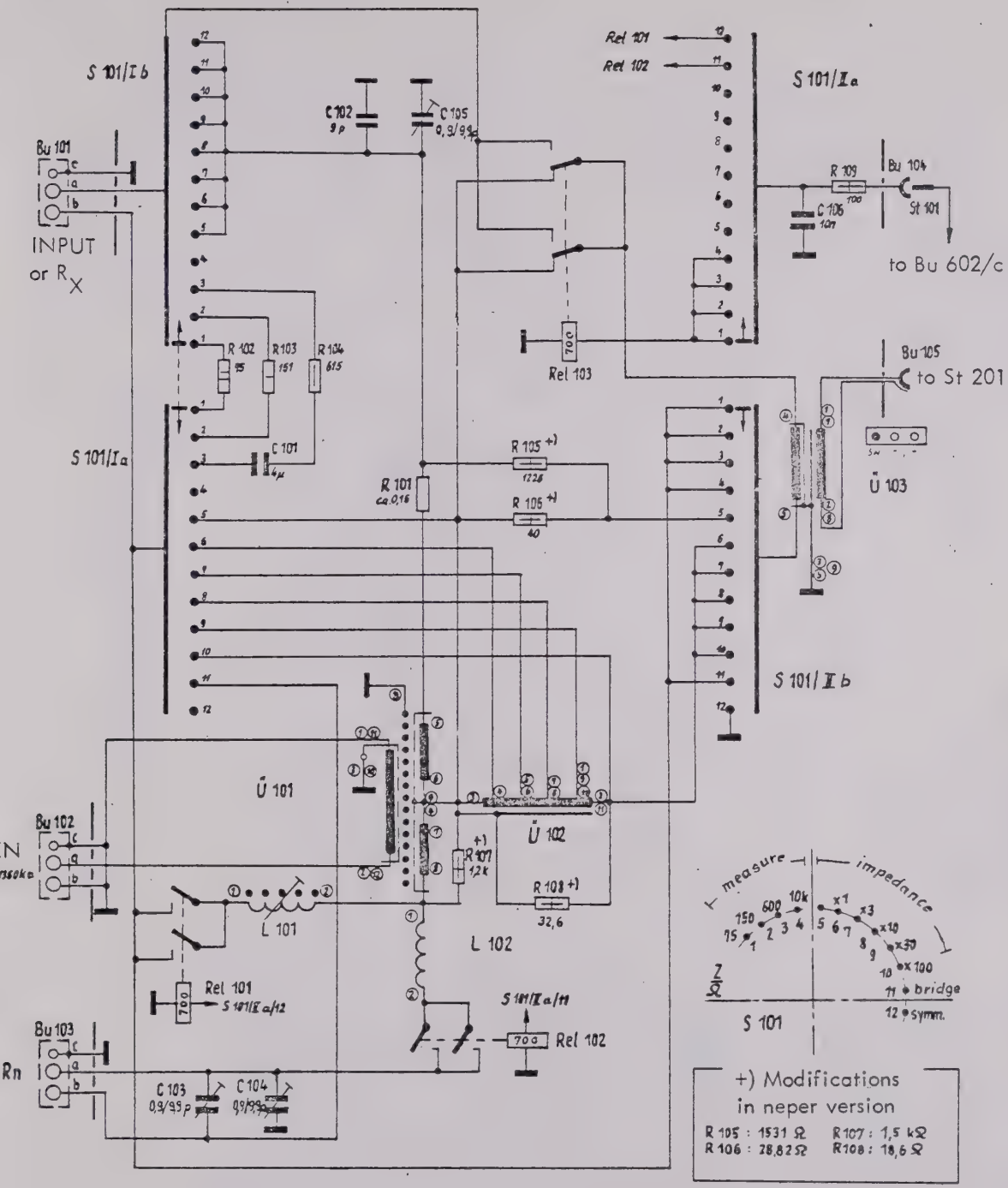


CRYSTAL FILTER

TFPM-76 Series H ff.

ALIGNMENT PROCEDURE

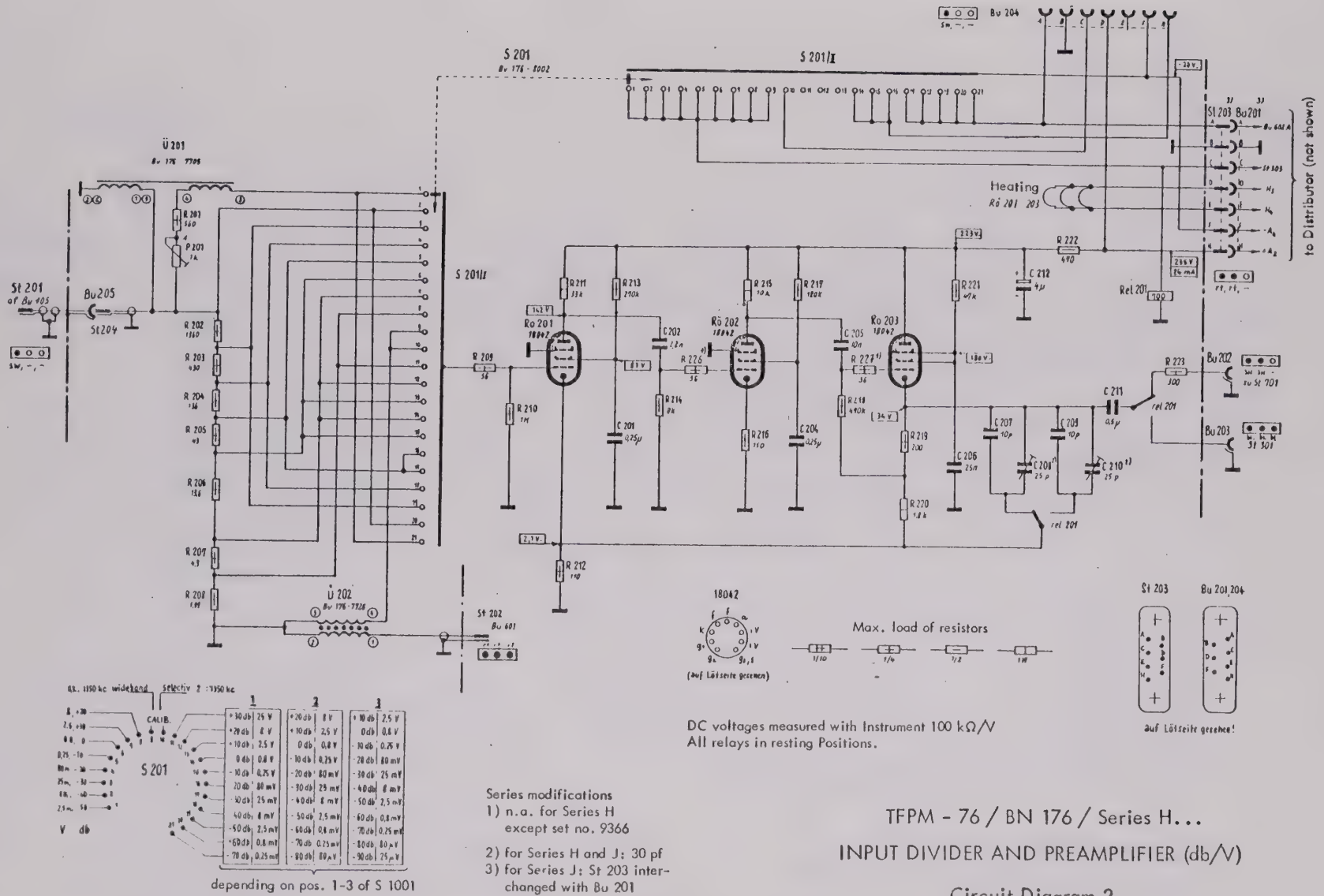
BAYTRON SYSTEMS CORP.
1720 Newport Circle
Santa Ana, Calif. 92705



TFPM - 76/BN 176/ Series H...

ATTACHMENT

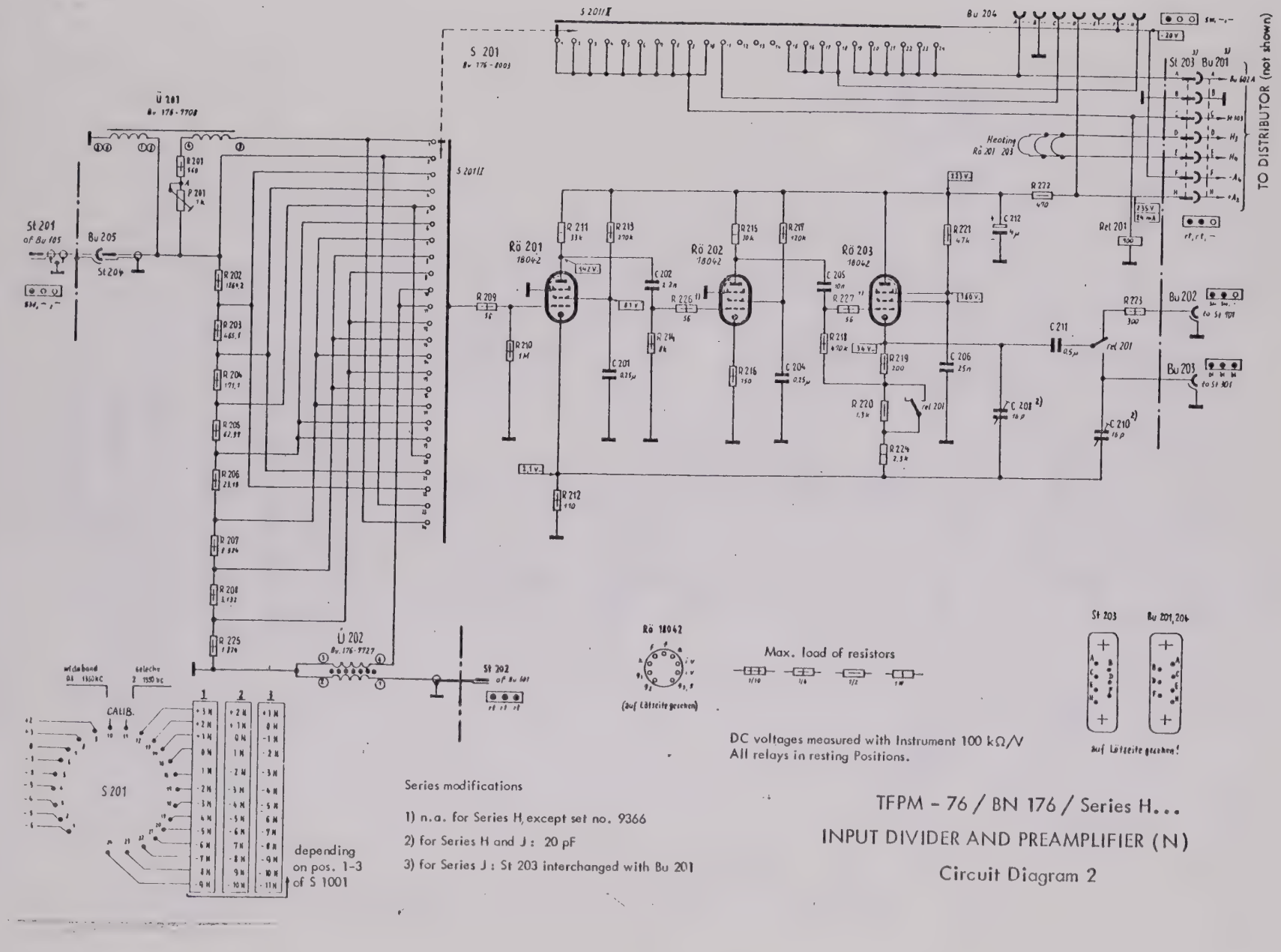
Circuit Diagramm 1

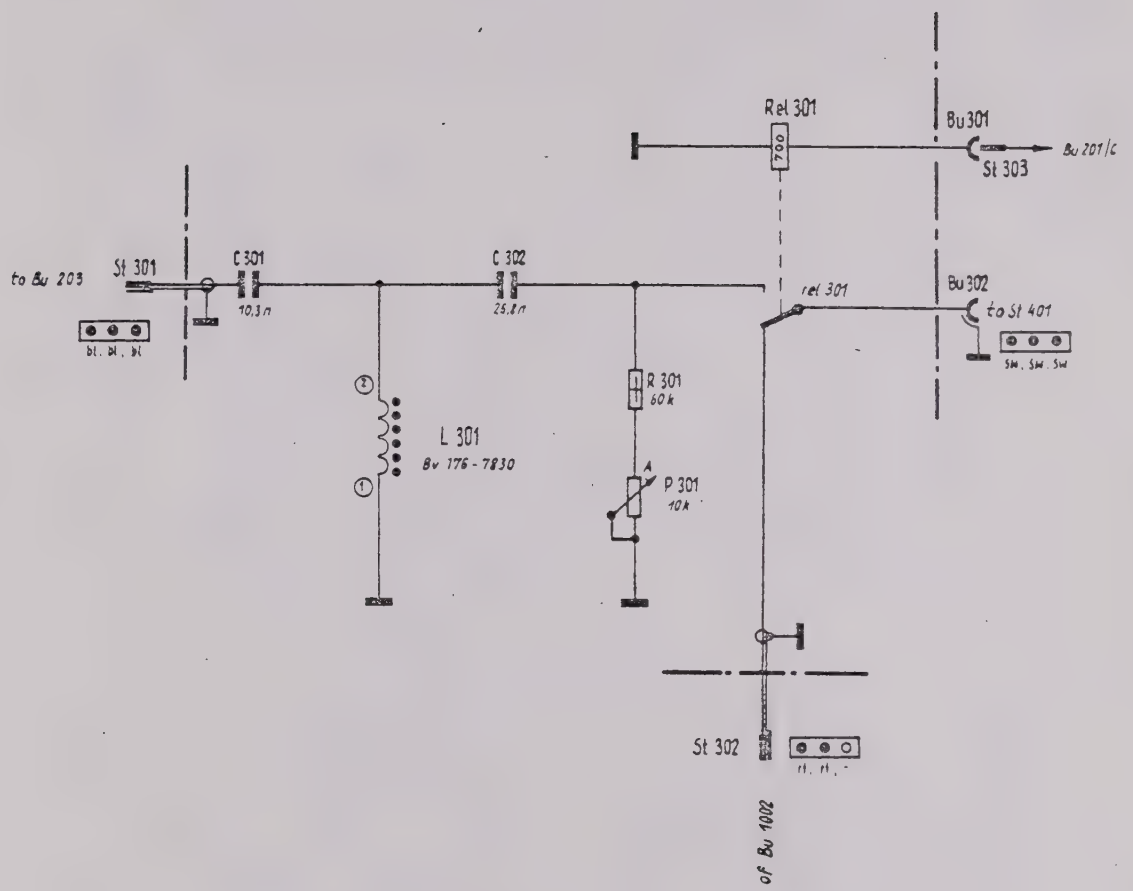


TFPM - 76 / BN 176 / Series H...

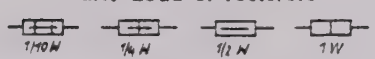
INPUT DIVIDER AND PREAMPLIFIER (db/V)

Circuit Diagram 2


S 201
S 201 I
S 201 II
Ü 201
Ü 202
St 201
Bu 205
St 204
Rö 201
Rö 202
Rö 203
R 209
R 210
R 211
R 212
R 213
R 214
R 215
R 216
R 217
R 218
R 219
R 220
R 221
R 222
R 223
R 224
R 225
R 226
R 227
C 201
C 202
C 204
C 205
C 206
C 207
C 208
C 210
C 211
C 212
Rel 201
Bu 202
Bu 203
St 203
Bu 201
Bu 204
St 202
P 201
R 201
R 202
R 203
R 204
R 205
R 206
R 207
R 208
CALIB.
TO DISTRIBUTOR (not shown)
Heating
Rö 201 203
depending on pos. 1-3 of S 1001
Max. load of resistors
DC voltages measured with Instrument 100 kΩ/V
All relays in resting Positions.
Series modifications
1) n.a. for Series H, except set no. 9366
2) for Series H and J : 20 pF
3) for Series J : St 203 interchanged with Bu 201
TFPM - 76 / BN 176 / Series H...
INPUT DIVIDER AND PREAMPLIFIER (N)
Circuit Diagram 2



Max. Load of resistors

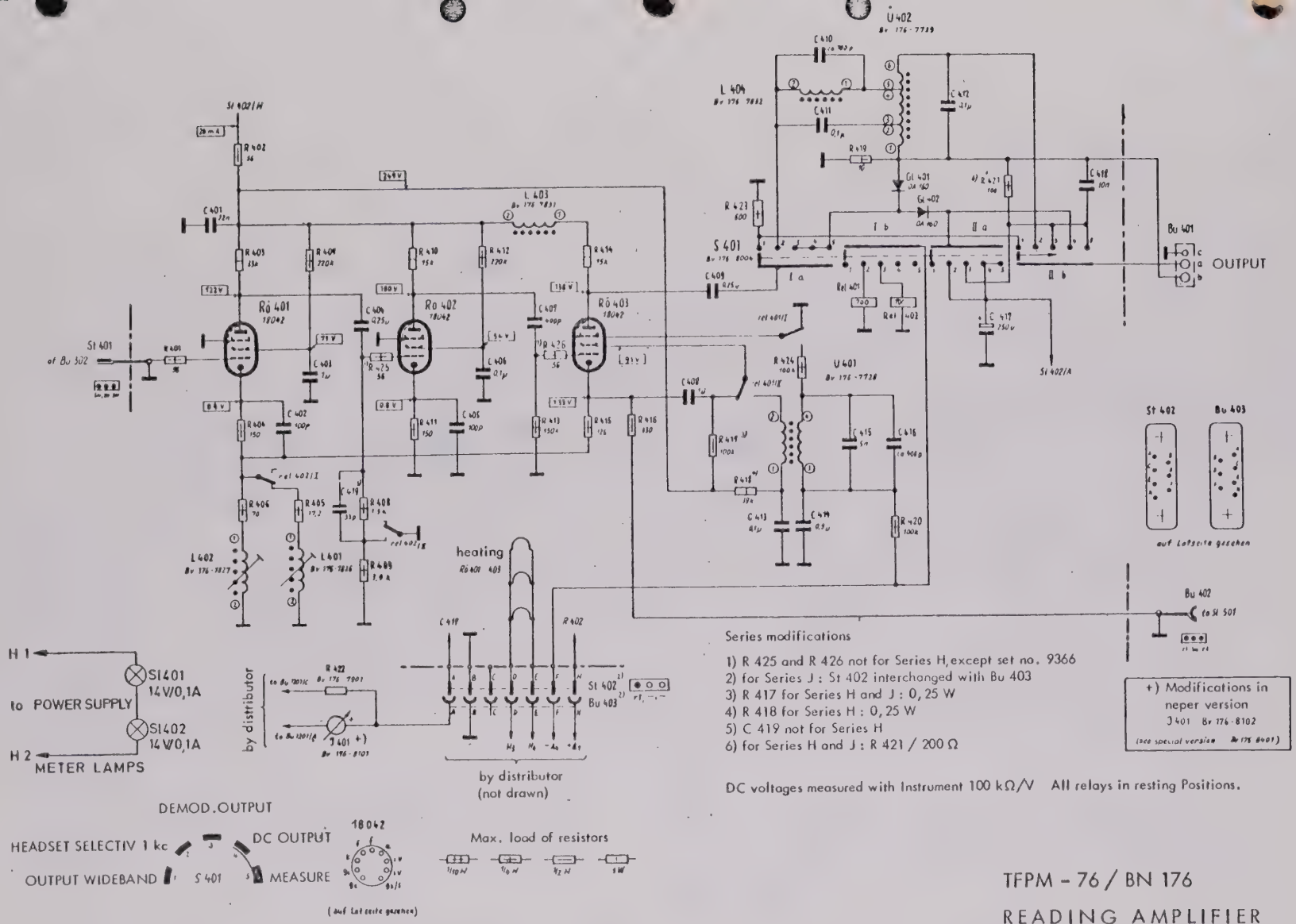


All relays in resting Position.

TFPM - 76 / BN 176 / Series H...

HIGHPASS FILTER NETWORK 300 CPS

Circuit Diagram 3



Series modifications

1) R 425 and R 426 not for Series H, except set no. 9366
2) for Series J : St 402 interchanged with Bu 403
3) R 417 for Series H and J : 0, 25 W
4) R 418 for Series H : 0, 25 W
5) C 419 not for Series H
6) for Series H and J : R 421 / 200 Ω

+) Modifications in neper version
J 401 Bv 176-8102
(see special version Bv 176 8401)

DC voltages measured with Instrument 100 kΩ/V All relays in resting Positions.

TFPM - 76 / BN 176

READING AMPLIFIER

Circuit Diagram 4

TFPM -76 / BN 176 / Series K...

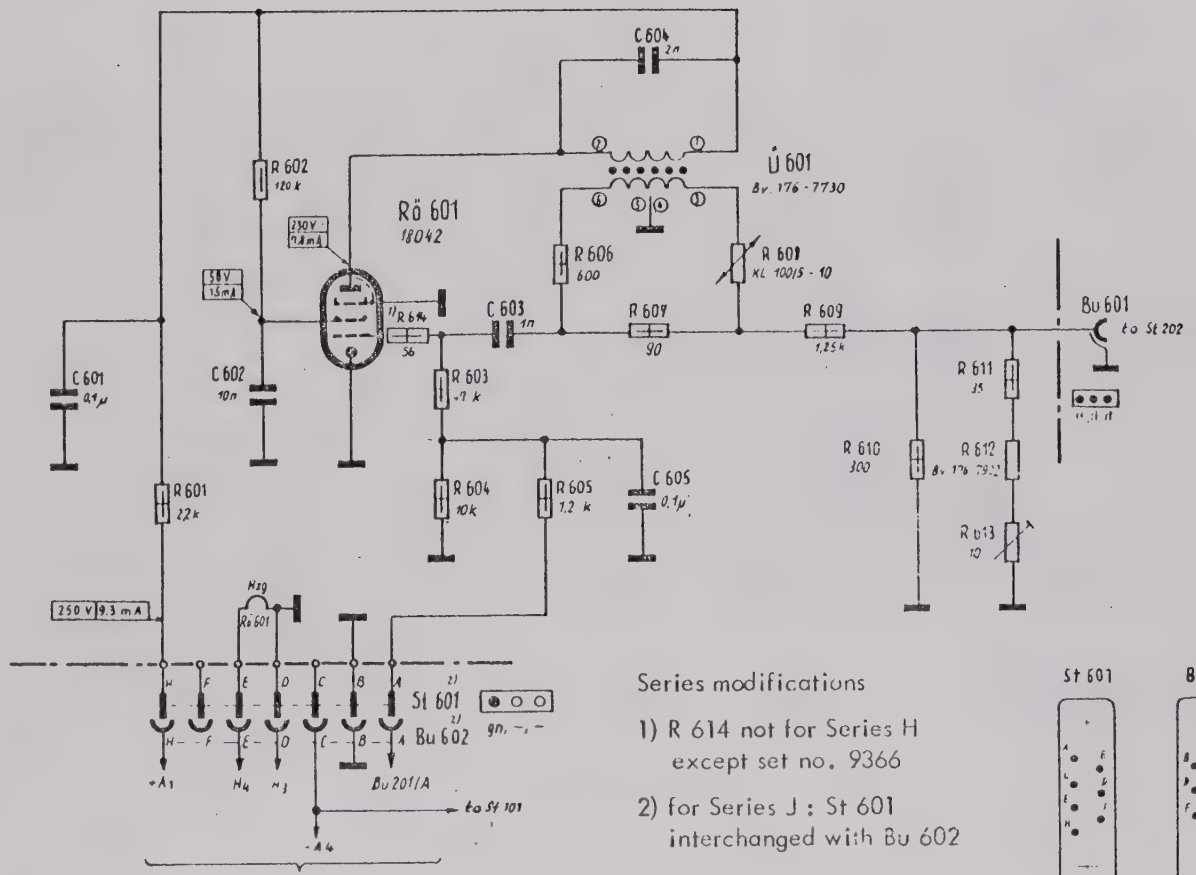
HF-FINAL AMPLIFIER

Circuit Diagram 5

TFPM-76 / BN 176 / Series H...

CALIBRATION OSCILLATOR

Circuit Diagram 6



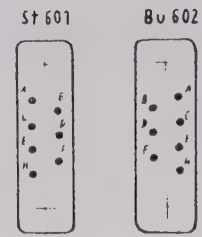
Max. Load of resistors

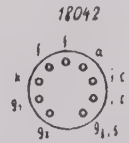
1/10 W 1/4 W 1/2 W 1 W

Series modifications

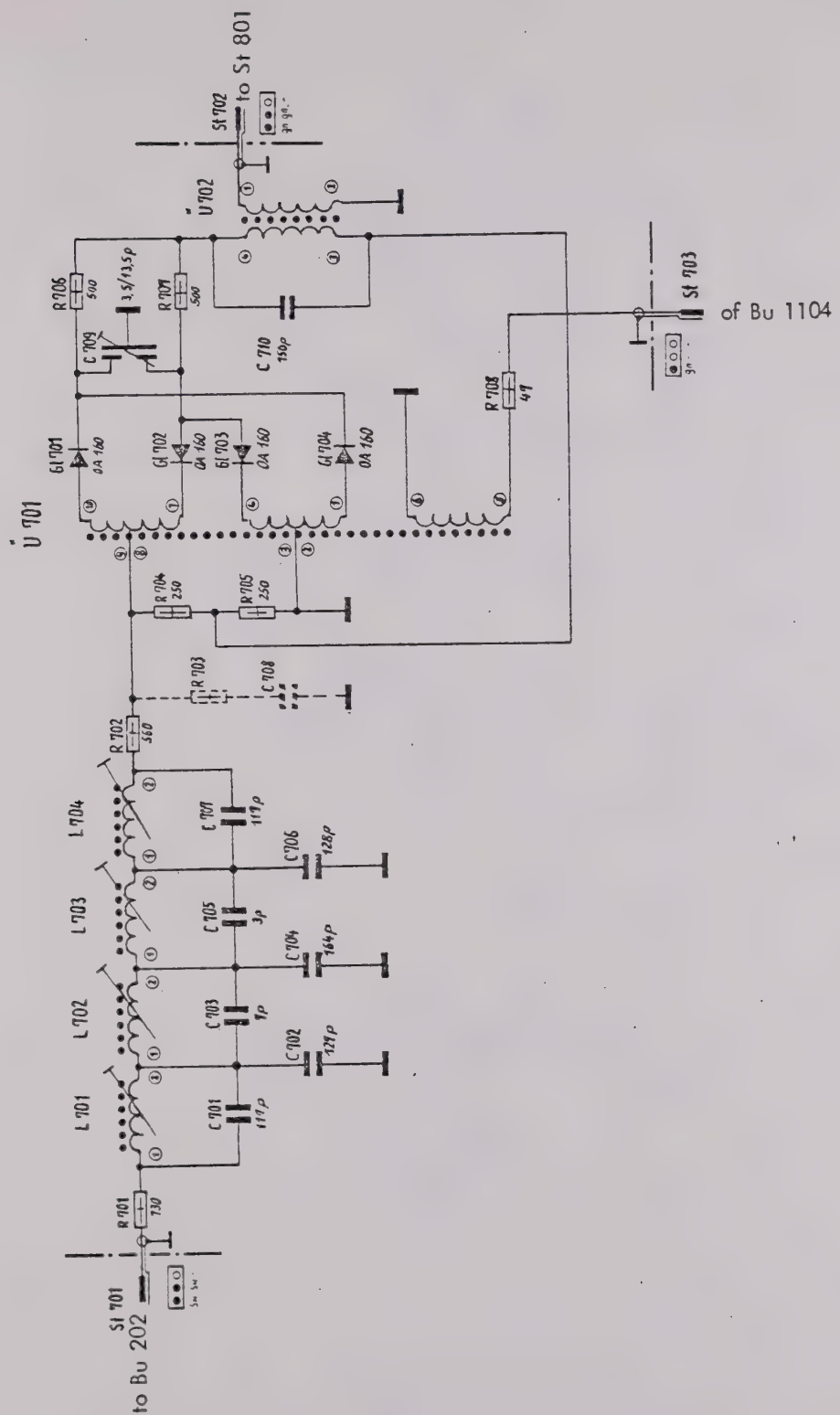
1) R 614 not for Series H except set no. 9366

2) for Series J : St 601 interchanged with Bu 602





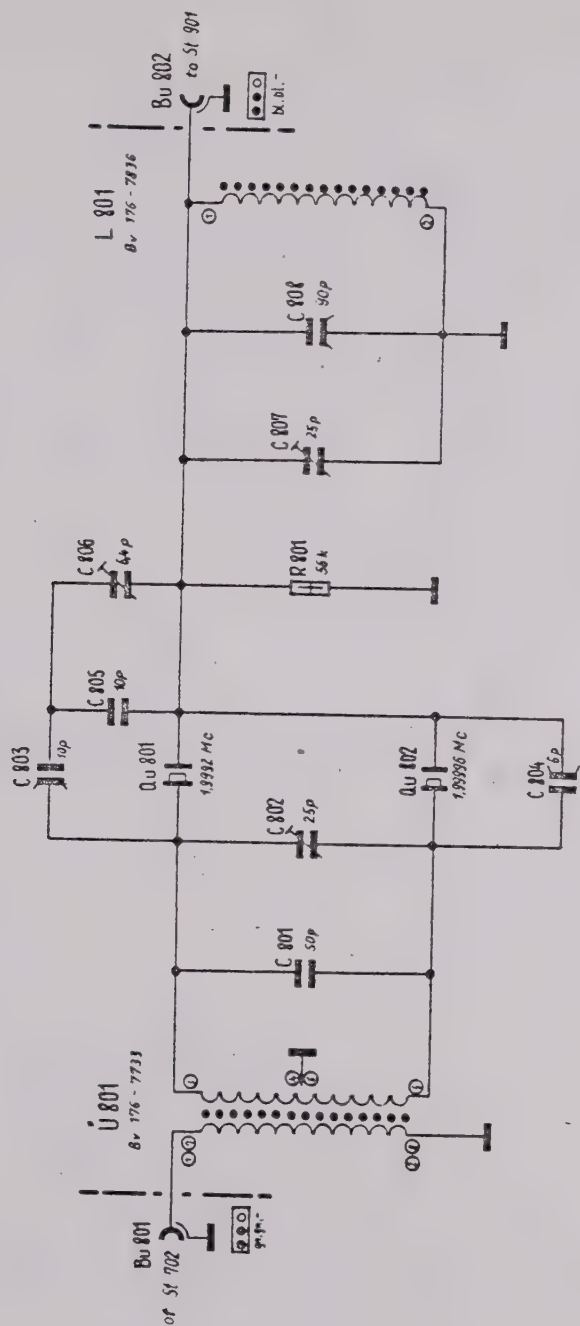
DC voltages measured with Instrument 100 kΩ/V



TFPM - 76/BN 176 /Series H..

LOWPASS FILTER AND MODULATOR

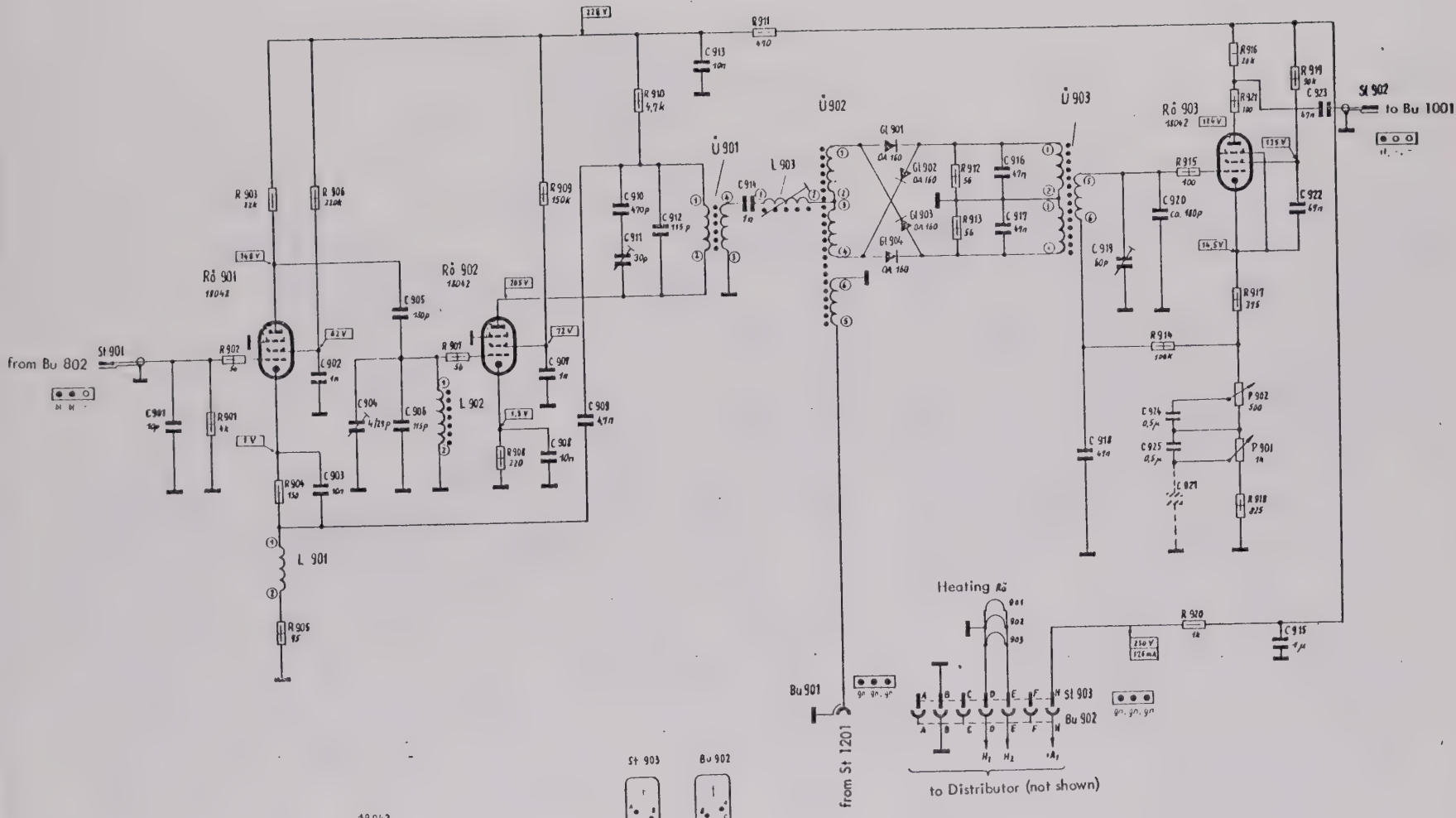
Circuit Diagramm 7



TFPM - 76 / BN 176 / Series H...

CRYSTAL FILTER 2 MC ± 560 CPS
(Bv. 176-9201)

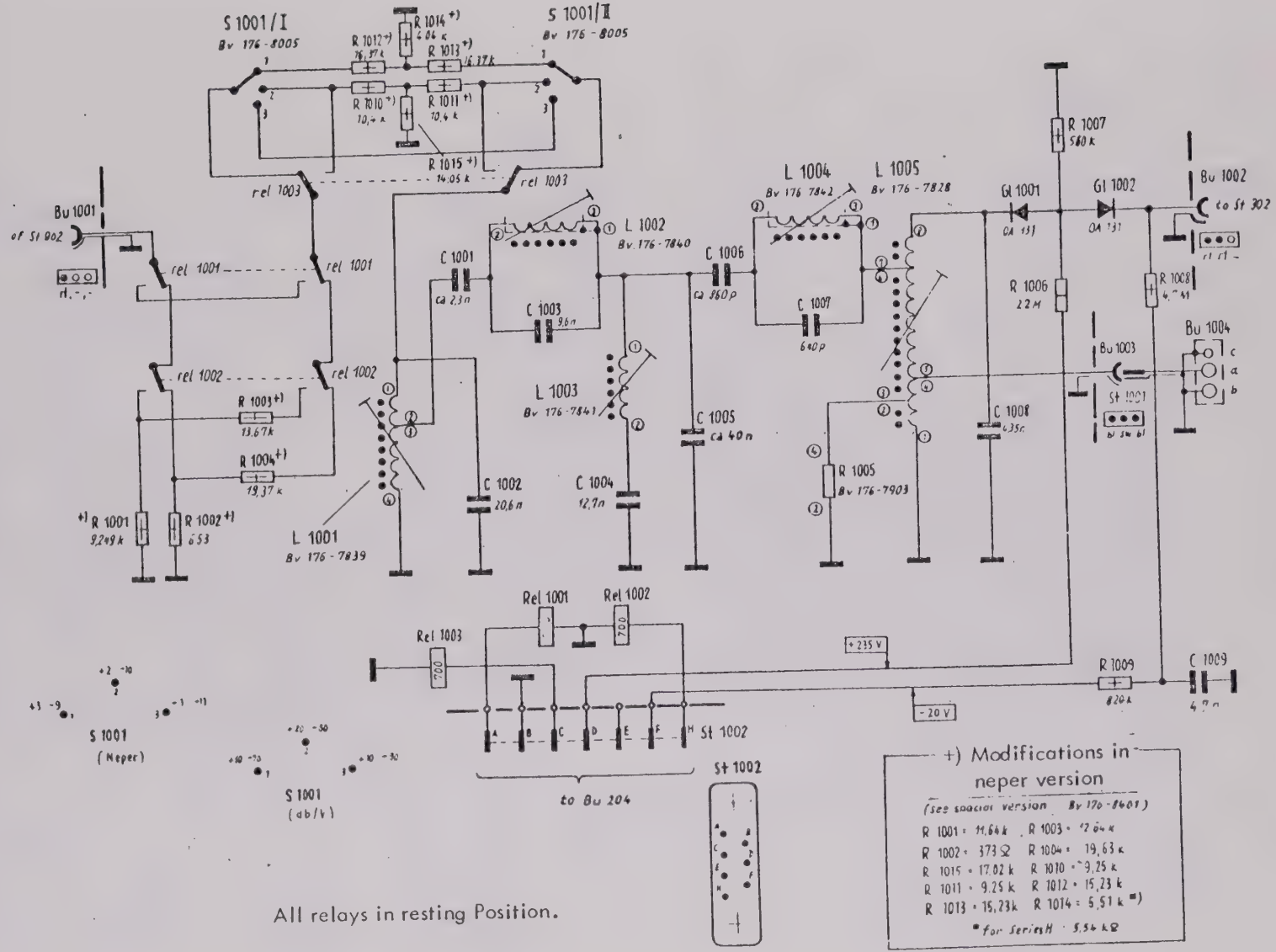
Circuit Diagram 8



TFPM -76/BN 176/Series H...

IF - AMPLIFIER AND MODULATOR

Circuit Diagram 9



All relays in resting Position.

TFPM - 76 / BN 176 / Series H...

BANDPASS FILTER NETWORK 4 KC

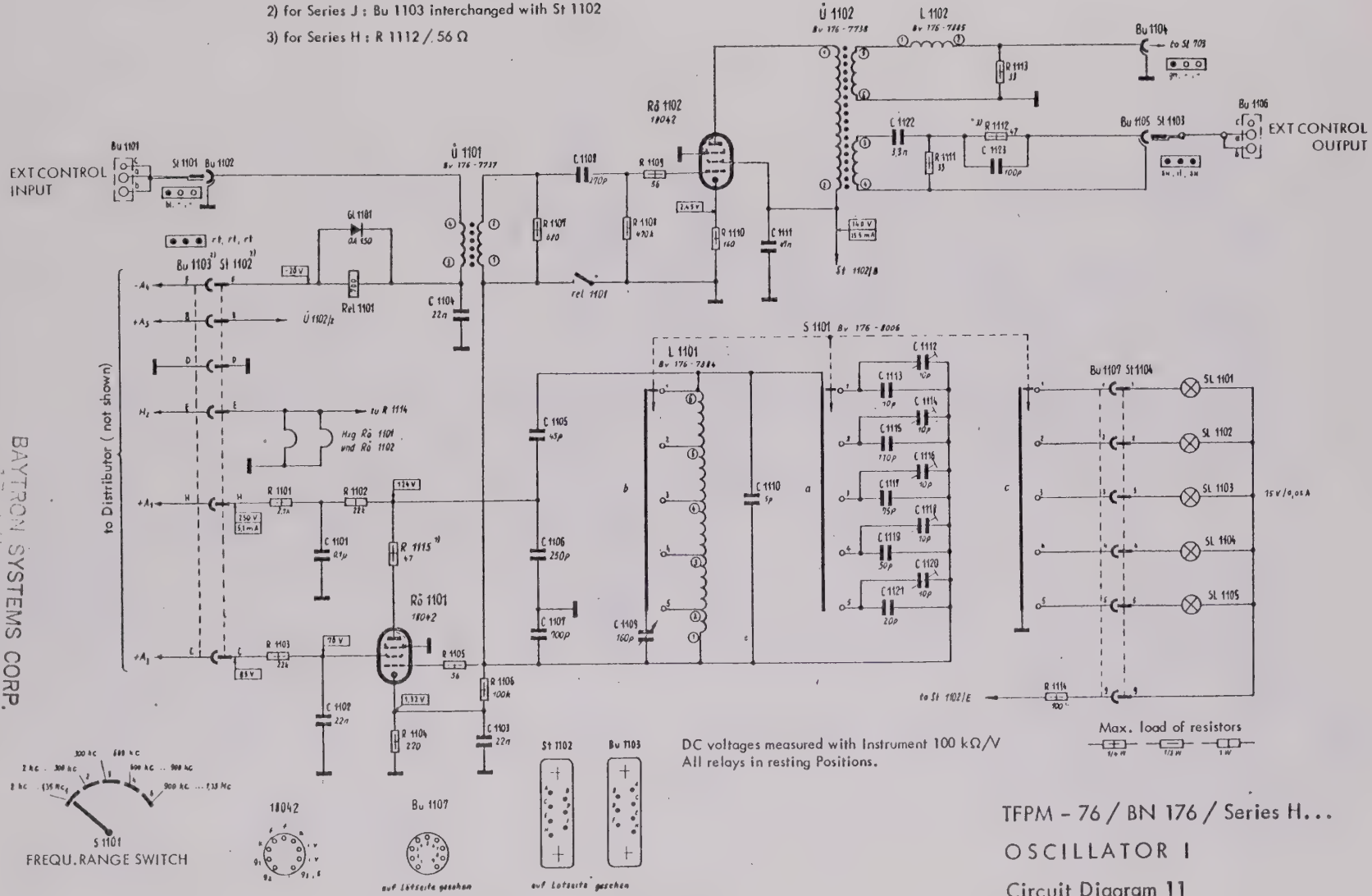
Circuit Diagram 10

Series modifications

1) R 1115 n.a. for Series H

2) for Series J : Bu 1103 interchanged with St 1102

3) for Series H : R 1112 / 56 Ω



TFPM - 76 / BN 176 / Series H...

OSCILLATOR I

Circuit Diagram 11

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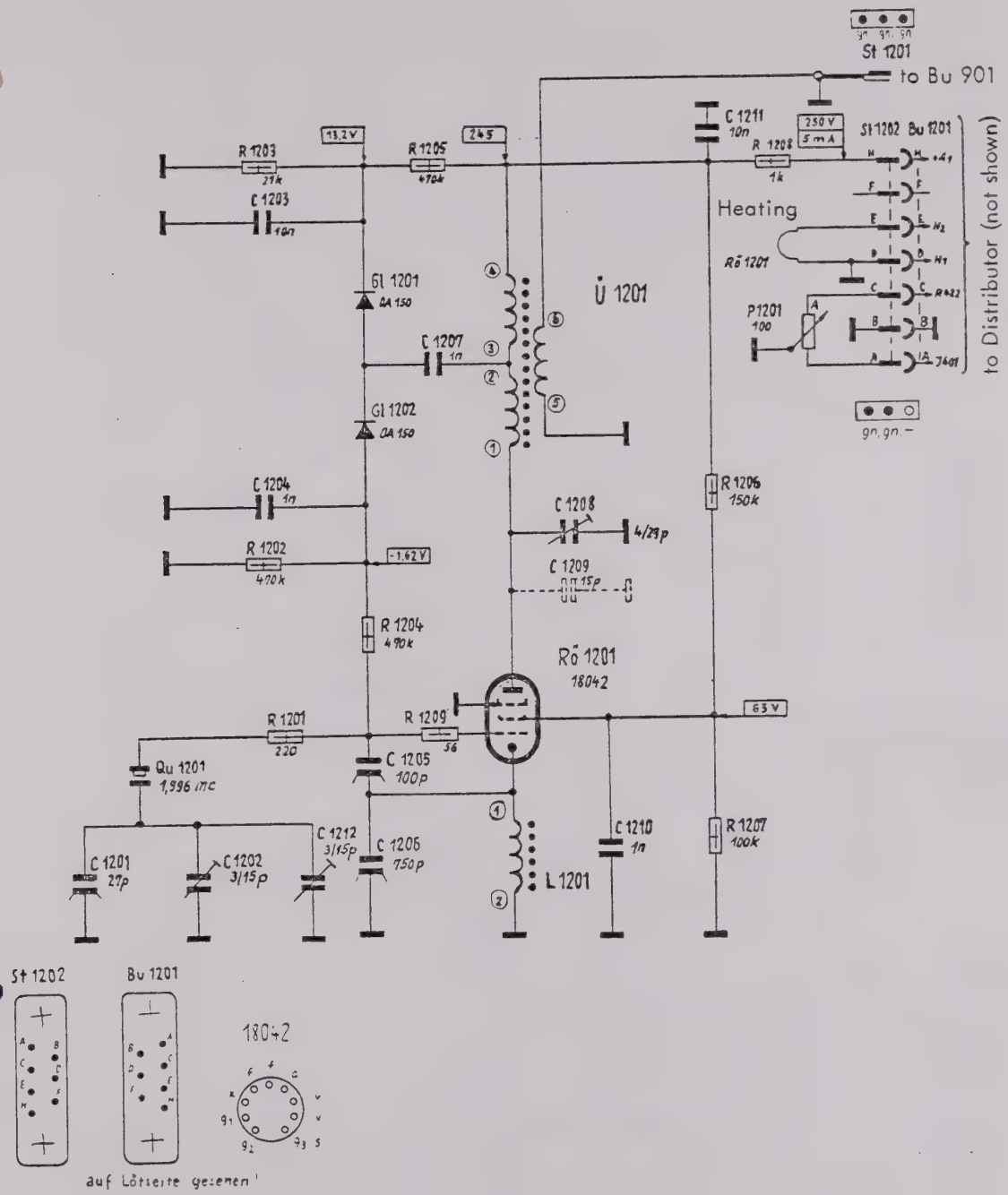
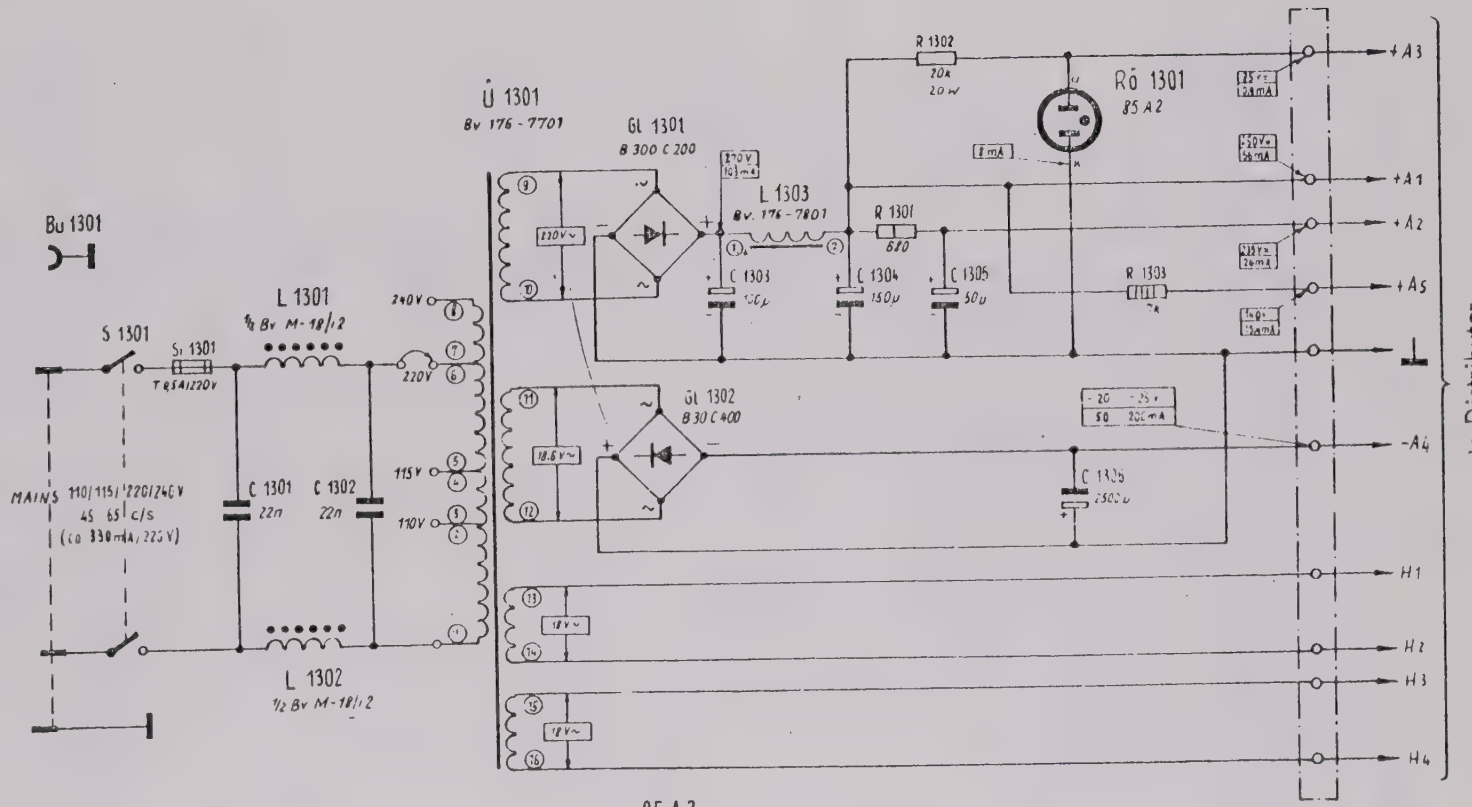
Santa Ana, Calif. 92705



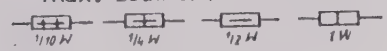
TFPM -76/ BN 176 /Series H...

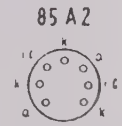
OSCILLATOR II

Circuit Diagramm 12



Max. Load of resistors





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DC voltages measured with Instrument 100 kΩ/V

Series modifications : 1) for Series H and J : R 1302 / 24 W

TFPM - 76 / BN 176 / Series H...

POWER SUPPLY

Circuit Diagram 13

Sollten die Werte bestimmter Bauelemente in den Stromlaufplänen und Schaltteillisten differieren, so sind stets die Angaben in den Schaltteillisten als verbindlich anzusehen.

If the values of individual components listed in the circuit diagrams and component lists should differ from another, those values given in the component lists are valid.

Widerstände (Resistors)

R 101	ca. 150 mΩ	Konstantan 0,3 mm		Abweichungen in der
R 102	75 Ω	2 W	1 %	Np-Ausführung
R 103	151 Ω	1 W	1 %	Deviations with Np model
R 104	615 Ω	0,5 W	1 %	
R 105	1226 Ω	0,33 W	0,5 %	1531 Ω
R 106	40 Ω	0,33 W	0,5 %	28,82 Ω
R 107	1,2 kΩ	0,25 W	5 %	1,5 kΩ
R 108	32,6 Ω	0,33 W	0,5 %	18,6 Ω
R 109	100 Ω	0,25 W	5 %	

Kondensatoren (Capacitors)

C 101	4 µF	63 V	20 %	MKL
C 102	9 pF	500 V	±0,5 pF	Keram.
C 103,104,105	0,9/9,9 pF			Trimmer
C 106	10 nF	400 V		

Korrekturanmerkungen zur Schaltteilliste

(Corrections to the Parts List)

R 207, 208, 214	0,33 W	
R 213	0,25 W	
R 513	1,4 W	
R 1006	2 W	
P 1201	0,25 W	
C 301, 302, 402, 405, 410...412, 710, 914, 920, 1001...1005,		
C 1008, 1108	160 V	
C 1006, 1106, 1206	630 V	
C 402	100 pF	
C 416	330 pF 470 pF	Kunst.-Folie (plastic-foil) Abgleichwert (alignment value)
GI 701...704, 901...904	AA 138 [1]	
GI 1101, 1201, 1202	AA 132 [2]	
GI 1301	B 300 C 250	SEL

Serie S (Series S): 1) OA 160 2) OA 150

					Abweichungen bei der Np - Ausführung
Widerstände, Resistors					
R 201	560 Ω	0,25 W	5 %		
R 202	1360 Ω	0,33 W	0,5 %		1264,2 Ω
R 203	430 Ω	0,33 W	0,5 %		465,1 Ω
R 204	136 Ω	0,33 W	0,5 %		171,1 Ω
R 205	43 Ω	0,33 W	0,5 %		62,97 Ω
R 206	13,6 Ω	0,33 W	0,5 %		23,15 Ω
R 207	4,3 Ω	0,25 W	0,5 %		8,524 Ω
R 208	1,99 Ω	0,25 W	0,5 %		3,132 Ω
R 209	56 Ω	0,25 W	5 %		
R 210	1 MΩ	0,25 W	5 %		
R 211	33 kΩ	1 W	5 %		
R 212	110 Ω	0,33 W	0,5 %		
R 213	270 kΩ	0,33 W	5 %		
R 214	8 kΩ	0,25 W	1 %		
R 215	10 kΩ	1 W	5 %		
R 216	150 Ω	0,25 W	5 %		
R 217	120 kΩ	0,25 W	5 %		
R 218	470 kΩ	0,25 W	5 %		
R 219	200 Ω	0,33 W	1 %		
R 220	1,8 kΩ	1 W	0,5 %		1,3 kΩ
R 221	47 kΩ	0,25 W	5 %		
R 222	470 Ω	0,5 W	5 %		
R 223	300 Ω	0,33 W	1 %		
R 224					2,3 kΩ
R 225					1,824 Ω
R 226	56 Ω	0,25 W	5 %		
R 227	56 Ω	0,25 W	5 %		
P 201	1 kΩ	linear		Einstellpotentiometer	
Kondensatoren, Capacitors					
C 201	0,25 µF	400 V		MP	
C 202	2,2 nF	500 V-	2,5 %	Kunst.-Folie (plastic-foil)	
C 204	0,25 µF	400 V			
C 205	10 nF	400 V			
C 206	22 nF	250 V		MKH	
C 207	10 pF	500 V	±1 pF		entfällt
C 208	4/29 pF			Trimmer	
C 209	10 pF	500 V	±1 pF		entfällt
C 210	4/29 pF			Trimmer	
C 211	0,47 µF	400 V		MKH	
C 212	4 µF	350 V		Elko	
Röhren, Tubes					
Rö 201,202,203	18042			Valvo mikrofoniearm (roter Pumpstutzen)	

Widerstände, Resistors				
R 401	56 Ω	0,25 W	5 %	
R 402	56 Ω	0,5 W	5 %	
R 403	33 kΩ	1 W	5 %	
R 404	150 Ω	0,25 W	5 %	
R 405	17,2 Ω	0,33 W	0,5 %	
R 406	70 Ω	0,33 W	0,5 %	
R 407	220 kΩ	0,25 W	5 %	
R 408	1,5 kΩ	0,25 W	5 %	
R 409	3,9 kΩ	0,25 W	5 %	
R 410	15 kΩ	1 W	5 %	
R 411	150 Ω	0,25 W	5 %	
R 412	220 kΩ	0,25 W	5 %	
R 413	150 kΩ	0,25 W	5 %	
R 414	15 kΩ	1 W	5 %	
R 415	125 Ω	0,33 W	0,5 %	
R 416	330 Ω	0,25 W	5 %	
R 417	100 kΩ	0,5 W	5 %	
R 418	39 kΩ	1 W	5 %	
R 419	10 Ω	0,25 W	5 %	
R 420	100 kΩ	0,25 W	5 %	
R 421	100 Ω	0,33 W	1 %	
R 422		Kupferwiderstand		
R 423	600 Ω	0,33 W	1 %	
R 424	100 kΩ	0,25 W	5 %	
R 425	56 Ω	0,25 W	5 %	
R 426	56 Ω	0,25 W	5 %	

Kondensatoren, Capacitors				
C 401	22nF	400 V		
C 402	100 nF	125 V		Kunst.-Folie (plastic-foil)
C 403	1 µF	400 V		Kunst.-Folie (plastic-foil)
C 404	0,22 µF	400 V	20 %	MKH
C 405	100 pF	125 V		Kunst.-Folie (plastic-foil)
C 406	0,1 µF	400 V		
C 407	400 pF	500 V	10 %	Kunst.-Folie (plastic-foil)
C 408	1 µF	400 V		Kunst.-Folie
C 409	0,22 µF	400 V		MKH
C 410	680 pF	125 V	2,5 %	
	ca. 20 pF			Abgleichwert: ca. 700 pF
C 411,412	0,1 µF	125 V	2%	Kunst.-Folie
C 413	0,1 µF	400 V		
C 414	0,47 µF	63 V	20 %	MKL
C 415	5 nF	250 V	2,5 %	Kunst.-Folie
C 416	330 pF u.730pF	500 V	2,5 %	Abgleichwert ca. 400 pF
C 417	250 µF	6 V	-20%/+50%	Elko
C 418	10 nF	400 V		
C 419	33 pF	125 V	± 5 %	Kunst.-Folie
C 420	1 µF	63 V		MKL

SCHALTTEILLISTE 3		PARTS LIST 3		TFPM-76
Widerstände, Resistors				
R 301	60 kΩ	0,33	1 %	
Potentiometer				
P 301	10 kΩ	lin		
Kondensatoren, Capacitors				
C 301	10,3 nF	125 V	1 %	Kunst.-Folie (plastic-foil)
C 302	25,8 nF	125 V	1 %	Kunst.-Folie (plastic-foil)

Widerstände, Resistors				
R 501	6,8 kΩ	0,25 W	5 %	
R 502	3,3 kΩ	0,25 W	5 %	
R 503	22 kΩ	0,25 W	5 %	
R 504	2,2 kΩ	0,25 W	5 %	
R 505	120 Ω	0,25 W	5 %	
R 506	2,7 kΩ	0,25 W	5 %	
R 507	8,2 kΩ	0,25 W	5 %	
R 508	4,7 kΩ	0,25 W	5 %	
R 510	330 Ω	0,25 W	5 %	
R 511	220 Ω	0,25 W	5 %	
R 512	47 Ω	0,25 W	5 %	
R 513	180 Ω	2 W	5 %	
Kondensatoren, Capacitors				
C 501	10 µF	6/8 V		Elko
C 502	0,47 µF	63 V		MKL
C 503	1 pF	500 V	± 0,25 pF	Keram.
C 504	2 µF	35 V-	-20%/+50%	Elko
C 506, 507	100 µF	15/18 V	-20%/+50%	Elko
Transistoren, Transistors				
T 501, 502	AF 116			Valvo
T 503	ASZ 10			Telefunken
Dioden				
GI 501	ZL 10	10,8 V ± 2%		Intermetall
GI 502	AAZ 13			Valvo

Röhren, Tubes		
Rö 401,402,403	18042	Valvo
Dioden, Diodes		
GI 401, 402	OA 160	Telefunken

Widerstände, Resistors				
R 701	730 Ω	0,33 W	1%	
R 702	560 Ω	0,33 W	1 %	
R 704,705	250 Ω	0,33 W	1 %	
R 706,707	500 Ω	0,33 W	1 %	
R 708	47 Ω	0,25 W	5 %	
Kondensatoren, Capacitors				
C 701	117 pF	500 V	1 %	Keram.
C 702	127 pF	500 V	1 %	Keram.
C 703	7 pF	500 V	± 0,5 pF	Keram.
C 704	164 pF	500 V	1 %	Keram.
C 705	3 pF	500 V	± 0,5 pF	Keram.
C 706	128 pF	500 V	1 %	Keram.
C 707	117 pF	500 V	1 %	Keram.
C 709	3,5/13,5 pF			Trimmer
C 710	150 pF	125 V	2,5 %	Kunst.-Folie (plastic-foil)
Dioden, Diodes				
GI 701,702,...704	OA 160			Telefunken

Widerstände, Resistors				
R 601	2,2 kΩ	0,25 W	5 %	
R 602	120 kΩ	0,5 W	5 %	
R 603	47 kΩ	0,25 W	5 %	
R 604	10 kΩ	0,25 W	5 %	
R 605	1,2 kΩ	0,25 W	5 %	
R 606	600 Ω	0,33 W	1 %	
R 607	90 Ω	0.33 W	1 %	
R 608	100 Ω			Kaltleiter
R 609	1,25 kΩ	0,33 W	0,5 %	
R 610	150 bis 600 Ω	0,25 W	0,5 %	Abgleichwert ca. 300 Ω
R 611	35 Ω	0,33 W	0,5 %	
R 612	20 Ω		0,5 %	Spindel-
R 613	9 Ω		0,5 %	widerstand
R 614	56 Ω	0,25 W	5 %	
Kondensatoren, Capacitors				
C 601	0,1 µF	400 V		
C 602	10 nF	400 V		
C 603	1 nF	1000 V		
C 604	2 nF	250 V	2,5 %	Kunst.-Folie (plasic-foil)
C 605	0,1 µF	250 V		
Röhre, Tube				
Rö 601	18042			Valvo

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Widerstände, Resistors				
R 901	4 kΩ	0,33 W	1 %	
R 902	56 Ω	0,25 W	5 %	
R 903	22 kΩ	0,5 W	5 %	
R 904	150 Ω	0,25 W	5 %	
R 905	75 Ω	0,33 W	0,5 %	
R 906	220 kΩ	0,25 W	5 %	
R 907	56 Ω	0,25 W	5 %	
R 908	220 Ω	0,25 W	5 %	
R 909	150 kΩ	0,25 W	5 %	
R 910	4,7 kΩ	0,25 W	5 %	
R 911	470 Ω	0,5 W	5 %	
R 912, 913	56 Ω	0,25 W	5 %	
R 914	100 kΩ	0,25 W	5 %	
R 915	100 Ω	0,25 W	5 %	
R 916	20 kΩ	1 W	0,5 %	
R 917	375 Ω	0,33W	1 %	
R 918	825 Ω	0,33 W	1 %	
R 919	90 kΩ	0,33 W	1 %	
R 920	1 kΩ	0,5 W	5 %	
R 921	100 Ω	0,25 W	5 %	
P 901	1 kΩ/lin.			Potentiometer
P 902	500 Ω/lin.	0,15 W		Potentiometer
Kondensatoren, Capacitors				
C 901	10 pF	500 V	± 0,5 pF	Keram.
C 902	1 nF	1000 V		
C 903	10 nF	400 V		
C 904	4/29			Trimmer
C 905	180 pF	500 V	2,5 %	Kunst.-Folie (plastic-foil)
C 906	115 pF	500 V	2 %	Keram.
C 907	1 nF	1000 V		
C 908	10 nF	400 V		
C 909	4,7 nF	1000 V		
C 910	470 pF	500 V	2,5 %	Kunst.-Folie (plastic-foil)
C 911	6/30 pF			Trimmer
C 912	115 pF	125 V	2,5 %	Abgleichwert
C 913	10 nF	400 V		
C 914	1 nF	125 V	2,5 %	
C 915	1 µF	400 V		Kunst.-Folie (plastic-foil)
C 916,917,918	47 nF	400 V		
C 919	10/60 pF			Trimmer
C 920	100 pF	125 V	2,5 %	Kunst.-Folie (plastic-foil)
C 922, 923	47 nF	400 V		
C 924, 925	2 x 0,5 µF	250 V		MP

Widerstände, Resistors				
R 801	56 kΩ	0,25 W	5 %	
Kondensatoren, Capacitors				
C 801	50 pF	500 V	5 %	Keram.
C 802	4/29 pF			Trimmer
C 803	10 pF	500 V	± 0,5 pF	Keram.
C 804	6 pF	500 V	+ 0,5 pF	Keram.
C 805	10 pF	500 V	± 0,5 pF	
C 806	4/10,4 pF			Trimmer
C 807	4/29 pF			Trimmer
C 808	90 pF	500		Keram.
Quarze, Crystals				
Qu 801	1,9992 MHz			
Qu 802	1,99996 MHz			

Widerstände, Resistors				
R 1001	9249 Ω	0,33 W	0,5 %	
R 1002	653 Ω	0,33 W	0,5 %	
R 1003	13,67 kΩ	0,33 W	0,5 %	
R 1004	19,37 kΩ	0,33 W	0,5 %	
R 1005	Kupferwid.			
R 1006	22 MΩ	1W	5%	
R 1007	560 kΩ	0,25 W	5 %	
R 1008	4,7 MΩ	0,25 W	5 %	
R 1009	820 kΩ	0,25 W	5 %	
R 1010, 1011	10,4 kΩ	0,33 W	0,5 %	
R 1012, 1013	16,37 kΩ	0,33 W	0,5 %	
R 1014	4,04 kΩ	0,33 W	0,5 %	
R 1015	14,05 kΩ	0,33 W	0,5 %	
Kondensatoren, Capacitors				
C 1001	2,3 nF	125 V	2 %	Kunst.-Folie (plastic-foil)
		125 V		Abgleichwert
C 1002	20,6 nF	125 V	2 %	Kunst.-Folie (plastic-foil)
C 1003	9,6 nF	125 V	2 %	Kunst.-Folie (plastic-foil)
C 1004	12,7 nF	125 V	2 %	Kunst.-Folie
C 1005	40 nF	125 V	2 %	Kunst.-Folie
		125 V		Abgleichwert
C 1006	800 pF	500 V	2 %	Kunst.-Folie
		125 V		Abgleichwert
C 1007	640 pF	500 V	2 %	Kunst.-Folie
C 1008	4,35 nF	125 V	2 %	Kunst.-Folie
C 1009	0,047 µF	400 V		
Dioden, Diodes				
GI 1001, 1002	OA 131			Telefunken

Röhren, Tubes		
Rö 901,902,903	18042	Valvo
Dioden, Diodes		
Gl 901,902,...,904	OA 160	Telefunken

Widerstände, Resistors				
R 1201	220 Ω	0,25 W	5 %	
R 1202	470 kΩ	0,25 W	5 %	
R 1203	27 kΩ	0,25 W	5 %	
R 1204,1205	470 kΩ	0,25 W	5 %	
R 1206	150 kΩ	0,25 W	5 %	
R 1207	100 kΩ	0,25 W	5 %	
R 1208	1 kΩ	0,25 W	5 %	
R 1209	56 Ω	0,25 W	5 %	
P 1201	100 Ω/lin	2 W		Potentiometer
Kondensatoren, Capacitors				
C 1201	27 pF	500 V	2 %	Keram.
C 1202	3/15 pF			Trimmer
C 1203	10 nF	400 V		
C 1204	1 nF	1000 V		
C 1205	100 pF	500 V	2 %	Keram
C 1206	750 pF	500 V	2 %	Kunst.-Folie (plastic foil)
C 1207	1 nF	1000 V		
C 1208	4/29 pF			Trimmer
C 1210	1 nF	1000 V		
C 1211	10 nF	400 V		
C 1212	3/15 pF			Trimmer
Röhre, Tube				
Rö 1201	18042			Valvo
Quarz, Crystal				
Qu 1201	1,996 MHz			
Dioden, Diodes				
GI 1201, 1201	OA 130			Telefunken

Widerstände, Resistors

R 1101	2,7 kΩ	0,25 W	5 %	
R 1102	22 kΩ	1 W	5 %	
R 1103	22 kΩ	0,25 W	5 %	
R 1104	220 Ω	0,25 W	5 %	
R 1105	56 Ω	0,25 W	5 %	
R 1106	100 kΩ	0,25 W	5 %	
R 1107	680 Ω	0,25 W	5 %	
R 1108	470 kΩ	0,25 W	5 %	
R 1109	56 Ω	0,25 W	5 %	
R 1110	150 Ω	0,25 W	5 %	
R 1111	33 Ω	0,25 W	5 %	
R 1112	47 Ω	0,25 W	5 %	
R 1113	33 Ω	0,25 W	5 %	
R 1114	100 Ω	0,25 W	5 %	
R 1115	47 Ω	0,25 W	5 %	

Kondensatoren, Capacitors

C 1101	0,1 µF	400 V		
C 1102, 1103,1104	22 nF	400 V		
C 1105	45 pF	500 V	2 %	Keram.
C 1106	250 pF	1000 V	2 %	Kunst.-Folie (plastic-foil)
C 1107	700 pF	125 V	2,5 %	Kunst.-Folie
C 1108	270 pF	125 V	2,5 %	Kunst.-Folie
C 1109	15/175 pF			Trimmer
C 1110	5 pF	500 V	± 0,5 pF	Keram.
C 1111	47 nF	400 V		
C 1112	4/14 pF			Trimmer
C 1113	5 pF	500 V	± 0,5 pF	Keram.
C 1114	4/14			Trimmer
C 1115	100 pF	500 V	2 %	
	10 pF	500 V	2,5 %	Nennwert 110 pF
C 1116	4/14			Trimmer
C 1117	75 pF	500 V	2 %	Keram.
C 1118	4/14 pF			Trimmer
C 1119	50 pF	500 V	5 %	Keram.
C 1120	4/14			Trimmer
C 1121	20 pF	500 V	5 %	Keram.
C 1122	3,3 nF	500 V	2,5 %	Kunst.-Folie
C 1123	100 pF	500 V	2,5 %	Kunst.-Folie

Röhren, Tubes

Rö 1101, 1102	18042	Valvo	

Lampen, Lamps

Sl 1101,1102,...,1105	15 V	0,05 A

Diode

GL 1101	OA 150	Telefunken

Widerstände, Resistors				
R 1301	680 Ω	1 W	5 %	
R 1302	20 kΩ	20 W	10 %	Draht (wire)
R 1303	7 kΩ	4 W	10 %	Draht (wire)
Kondensatoren, Capacitors				
C 1301,1302	22 nF	630 V-		
C 1303	100 µF	350 V-		Elko
C 1304	100 µF u. 50µF	350 V-		Elko
C 1305	50 µF	350 V		Elko
C 1306	2500 µF	35 V		Elko
Röhre, Tube				
Rö 1301	85 A 2			Valvo
Sicherung, Fuse				
Si 1301	T 0,5 A B	(220, 240V)	träge	
	T 1 A B	(110, 115V)	träge	
Gleichrichter, Rectifier				
Gl 1301	B 300 C 200 -2,5			Siemens
Gl 1302	B 30 C 400			Siemens

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